CENTERS FOR DISEASE CONTROL

January 18, 1991 / Vol. 40 / No. 2

MMWR

MORBIDITY AND MORTALITY WEEKLY REPORT

Epidemiologic Notes and Reports

Update: Transmission of HIV Infection during an Invasive Dental Procedure — Florida

Possible transmission of human immunodeficiency virus (HIV) infection during an invasive dental procedure was previously reported in a young woman (patient A) with acquired immunodeficiency syndrome (AIDS) (*1*). Patient A had no identified risk factor for HIV infection and was infected with a strain of HIV closely related to that of her dentist as determined by viral DNA sequencing. A follow-up investigation has identified four additional patients of the dentist who are infected with HIV. Laboratory and epidemiologic investigation has been completed on three of these patients (Table 1); two are infected with strains closely related to those of the dentist and patient A but not to strains from other persons residing in the same geographic area as the dental practice. The follow-up investigation included review of medical records of the dentist and interviews of former staff on the infection-control procedures of the dental practice. This report summarizes the findings of the investigation.*

Epidemiologic Investigation of the Dentist's Patients

Following the initial report (*1*), the dentist wrote an open letter to his former patients, which prompted 591 persons to be tested for HIV antibody at the Florida Department of Health and Rehabilitative Services (HRS) county public health units; two (patients B and C) were seropositive. In addition, one infected patient (patient D) was identified by HRS by matching the list of available names of the dentist's former patients with the state's AIDS surveillance records, and another (patient E) contacted CDC to report that she was HIV-infected and a former patient of this dentist. Although the exact number of patients in this dental practice is unknown, approximately 1100 additional persons who may have been patients of the dentist and who could be located have been contacted by HRS to offer counseling and HIV-antibody testing; of these persons, 141 have been tested, and all are seronegative.

*Single copies of this article will be available free until January 18, 1992, from the National AIDS Information Clearinghouse, P.O. Box 6003, Rockville, MD 20850; telephone (800) 458-5231.

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Patient B is an elderly woman for whom no risk factor for HIV infection could be established. She did not report intravenous (IV)-drug use or sexual contact with persons at risk for HIV infection. Based on interviews and review of her medical records, she had no history of transfusion, receipt of blood products, or illness compatible with an acute retroviral syndrome. Serologic tests for syphilis and hepatitis B virus (HBV) were negative. The patient's spouse, to whom she has been married >25 years, tested negative for HIV antibody.

Patient C is a young man who has reported multiple heterosexual partners and a history of non–IV-drug use, including one hospitalization for toxicity caused by an illicit drug. Other risk factors for HIV infection were suggested by secondary sources but were not corroborated by the patient. He had no history of transfusion, receipt of blood products, or illness compatible with an acute retroviral syndrome; serologic tests for syphilis and HBV were negative. His wife and other female sexual contacts who were tested were HIV seronegative.

Patient D is a man with AIDS with established risk factors for HIV infection. Patient E is a woman with HIV infection whose epidemiologic and laboratory investigation has not yet been completed. All patients (A–E) denied sexual contact with the dentist, and they did not name each other as sex partners.

From 1984 through 1989, patients A, B, and C made numerous visits to this dentist (Table 1) for a variety of procedures: patient A—extractions, prophylaxis (cleaning), and cosmetic bonding; patient B—extractions, prophylaxis, periodontal scaling and root planing, and fixed and removable prosthodontics; and patient C—extractions, prophylaxis, periodontal scaling and root planing, and restorative fillings.

On two occasions, two of these three patients had appointments on the same day: in 1987, patient B was examined for a toothache the same day patient A had two maxillary third molars extracted; in 1989, patients B and C had prophylaxes performed on the same day. Neither the order nor the time of day of their appointments could be determined because appointment books could not be located; also, whether the dentist provided dental care for patients B and C during their appointments for prophylaxes is unknown.

To examine the likelihood that patients shared visit days, two conditional probabilities were calculated based on the number of visits made by each patient (six for patient A, 21 for patient B, and five for patient C) from November 1987 through the

TABLE 1. HIV-infected patients in a dentist's practice for whom DNA sequencing data are available and investigations are completed

Patient*	Sex	Identified risk factor	Clinical status	Dental visits No.	Dental visits Dates
A	Female	No	AIDS	6	Nov. 1987–Jun. 1989
B	Female	No	Asymptomatic CD4 >200–<500/mm^3	21	Dec. 1987–Jul. 1989
C	Male	Not confirmed	Asymptomatic CD4 <200/mm^3	14	Dec. 1984–May 1989
D	Male	Yes	AIDS	19	Jun. 1985–May 1989

*HIV DNA sequences for patients A, B, and C were similar to each other and to those of the dentist.

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closure of the practice in July 1989[†]. These probabilities were calculated assuming visits occurred at random over the interval during days the dentist's office was open, without allowing multiple visits for the same patient on the same day. Given these assumptions, the probability of each of these patients having shared at least 1 day with another is 0.17; the probability of patients A and B having shared at least 1 day and patients B and C having shared at least 1 day is 0.13. These probabilities suggest that the shared visit days may have been chance events.

Laboratory Investigation

To determine the relatedness of the HIV strains from patients B, C, and D to those of the dentist and patient A, blood specimens were obtained from these patients and from eight HIV-infected persons (controls 1–8) randomly selected from two HIV clinics located within 90 miles of the dental practice. Six of the eight controls were men; the sex of the other two controls was not known. Most men in these clinics were either homosexual/bisexual or IV-drug users. Because the blood samples from the controls were collected anonymously, details of their sexual and dental histories were not available.

Sequencing of the HIV proviral DNA present in these specimens was performed at CDC using previously described methods (*1–4*).[§] The sequences included an approximately 300-base-pair variable region (V3) and/or an approximately 350-base-pair region, consisting of variable regions (V4 and V5) and a constant region (C3), encoding the amino acids of gp120. From one to 25 molecular clones obtained from each specimen were sequenced.[¶]

In collaboration with Los Alamos National Laboratory, computer-based methods were used to analyze the relationships of HIV DNA sequences from the dentist, the four dental patients (A–D), and the eight control patients and from 21 other North American isolates (*5*). Because of the sequence variation between multiple molecular clones of HIV DNA obtained from the same person, consensus sequences were derived to represent the major viral strain present in each person. For four persons (the dentist, patients A and D, and one of the control patients), two consensus sequences were created to encompass the range of their HIV sequence variation.

Sequence variation can be depicted by tree analysis (*5*). The viruses of the dentist and patients A, B, and C are closely related in their V3 sequences (Figure 1), with an average difference of 3.4%. This degree of sequence relatedness has been reported

[†]The interval during which at least two of these HIV-infected persons (patients A, B, and C) were patients of this dentist.

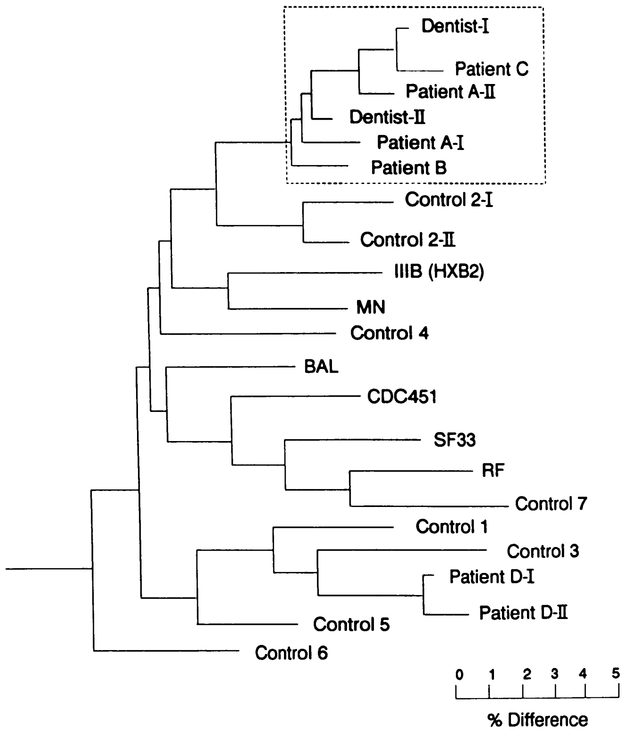
[§]HIV exhibits considerable genetic variability, particularly in the gene for its envelope glycoprotein (gp120), and analyses of DNA sequences of this gene can be used to determine the relations of viruses infecting different persons. Analyses of multiple molecular clones of HIV obtained from an infected person can also define the range of genetic variation in the virus infecting that person. Sequence differences are least for viral clones obtained from a single infected person, intermediate for viruses from persons whose infections are epidemiologically linked, and greatest for viruses from persons whose infections are epidemiologically unrelated (*5*).

[¶]To assure that no laboratory error occurred, DNA sequences from patients B, C, and D encoding the human leukocyte antigen DQ α were amplified by the polymerase chain reaction. The lengths of the sequences from these specimens were distinct from each other and from the sequence lengths found for the dentist and patient A (*1*), confirming that each of the samples represented a different person. As an additional verification of the source of each set of DNA sequences, DNA oligonucleotides corresponding to short sequences unique to the HIV strains from each of these three persons were used as hybridization probes. The probes hybridized only with DNA from the person from whose virus the probe was derived.

HIV – Continued

only for multiple HIV strains obtained from a single person or for HIV strains from persons whose infections were epidemiologically linked (*3,4*). In contrast, the V3 sequences from the dentist and patients A, B, and C were not closely related to the viral sequences from patient D, seven control patients, and the 21 other North American isolates. Furthermore, the average viral sequence difference for patient D and seven control patients was approximately 13% (range: 8%–15%), suggesting that no particular HIV strain predominates in the geographic area in which the dentist practiced and indicating that no other instance of comparable viral sequence relatedness was identified.

FIGURE 1. Tree analysis of V3 nucleotide sequences from the dentist; patients A, B, C, and D; and seven local control patients* and from six North American HIV isolates (IIIB [HXB2], MN, BAL, CDC451, SF33, and RF)



For the dentist, patients A and D, and control 2, alternate consensus sequences are indicated by Roman numerals (I and II). The horizontal branch lengths (see scale) indicate percent nucleotide differences calculated based on a total of 308 nucleotides from the V3 region. The percent difference between any two viruses can be determined by adding the horizontal branch lengths needed to connect the two. Vertical distances in the figure are for illustration purposes only. The dotted box indicates the cluster of closely related sequences present in the viruses from the dentist and patients A, B, and C. More distant North American HIV sequences are not shown.

*No V3 sequence was available for the remaining control patient.

HIV – Continued

In a separate analysis of a relatively conserved portion of the V4-C3-V5 region, including sequences from the eighth control, the viruses from the dentist and patients A, B, and C had an average difference of 1.8%, whereas the average difference of viruses from the local controls was 4.8%.

The low probability ($p=0.006$, Wilcoxon rank-sum statistic) that the HIV DNA sequences from patients A, B, and C would be closer by chance alone to the sequence from the dentist than to the sequences from the eight controls indicates that the viruses from patients A, B, and C are significantly more similar to the dentist's virus than to the viruses of the controls.

In addition, the HIV strains of the dentist and patients A, B, and C shared a unique pattern (or "signature sequence") of amino acids encoded by V3 nucleotides. This pattern was absent in the other sequences analyzed. This signature sequence provides additional evidence for the close relation among the viruses from the dentist and the three patients.

Medical History of the Dentist

Review of the dentist's medical records revealed that he was diagnosed with symptomatic HIV infection in late 1986, and AIDS in September 1987. At the time of the AIDS diagnosis, his CD4 lymphocyte count was $<200/mm^3$; zidovudine therapy was begun, discontinued for a short period in late 1987, then restarted and continued until after the practice closed in 1989. In 1988, he received radiation therapy for Kaposi's sarcoma of the palate. He performed invasive procedures on patients A and B after he was diagnosed with AIDS, including the brief period when he was not receiving antiretroviral therapy, and on patient C both before and after he was diagnosed with symptomatic HIV infection. While the dentist was in practice, he had no record of peripheral neuropathy, dementia, thrombocytopenia or other bleeding disorder, hand dermatitis, or injury.

Investigation of the Dental Practice

The office employees of the dentist were interviewed regarding infection-control and other work practices of the dental office. Of the 14 employees, eight have been tested for HIV antibody; all were negative, including the dental hygienists who could have performed prophylaxes on patients A, B, and C. Interviews revealed that no written policy or training course on infection-control principles or practice was provided for staff by the dentist and that no office protocol existed for reporting or recording injuries, such as needlesticks or other percutaneous injuries involving sharp instruments or devices. Anesthetic needles were either recapped by the dentist using a two-handed technique** or left uncapped and recapped by the assistant using a two-handed technique on completion of the dental treatment procedure. One seronegative staff person recalled sustaining an injury while washing sharp instruments, but no other specific incidents were reported by the staff. In addition, neither patient B nor patient C recalled, nor did review of the dental records indicate, any specific incidents that would have exposed them to the dentist's blood (i.e., an injury to the dentist, such as a needlestick or cut with a sharp instrument); however, no injury log was kept. The dentist could not be interviewed before his death regarding his care of these patients.

**Needle-recapping procedure in which the syringe with exposed needle is held in one hand and the needle cap or sheath is held in the other hand.

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Staff members reported that barrier precautions had been introduced into the practice by early 1987 and that all staff, including the dentist, wore latex gloves and surgical masks for patient-care activities. Staff reported that they changed gloves and washed their hands between most patient contacts; occasionally, however, they washed gloves rather than changed them between patient contacts. Masks reportedly were changed infrequently. Staff reported that the dentist's use of gloves and mask and handwashing practices were similar to their own. None of the staff reported a history of dermatitis.

Staff reported that by 1987 all surgical instruments were autoclaved. Nonsurgical heat-tolerant instruments (e.g., dental mirrors) were autoclaved when practice conditions, such as time and instrument supply, allowed or were immersed in a liquid chemical germicide for varying lengths of time. Tests of the autoclave in October 1990 demonstrated that it was functioning properly. Dental equipment, such as handpieces, prophylaxis angles, and air/water syringe tips, were not autoclaved but were either wiped with alcohol or immersed in a liquid chemical germicide at irregular intervals. Some disposable items (e.g., saliva ejectors, high-speed evacuation tubes, and prophylaxis cups) occasionally were reused after being immersed in a liquid chemical germicide for varying lengths of time. Germicides known to be available in the dental office were isopropyl alcohol and 2% glutaraldehyde. The dental practice had no written protocol or consistent pattern for operatory cleanup and instrument reprocessing.

Office staff also reported that the dentist occasionally received prophylactic treatment from the hygienists; at least one hygienist topically treated an oral lesion of the dentist on one occasion in 1987.

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Editorial Note: Based on the following considerations, this investigation strongly suggests that at least three patients of a dentist with AIDS were infected with HIV during their dental care: 1) the three patients had no other confirmed exposures to HIV; 2) all three patients had invasive procedures performed by an HIV-infected dentist; and 3) DNA sequence analyses of the HIV strains from these three patients indicate a high degree of similarity of these strains to each other and to the strain that had infected the dentist—a finding consistent with previous instances in which cases have been linked epidemiologically (*3,4*). In addition, these strains are distinct from the HIV strains from patient D (who had known behavioral risks for HIV infection), from the strains of the eight HIV-infected persons residing in the same geographic area, and from the 21 other North American isolates.

Because the dentist had known behavioral risk factors for HIV, his infection was probably not occupationally acquired. The precise mode of HIV transmission to patients A, B, and C remains uncertain. All three patients had invasive dental procedures performed by the dentist at times when he was known to be HIV-infected, with patients B and C each having multiple invasive procedures. Multiple opportunities existed for the dentist to sustain needlestick injuries (e.g., during administration of local anesthetics, two-handed needle-recapping procedures, and suturing) or cuts with a sharp instrument, particularly in poorly visualized operative sites. Although barrier precautions were reportedly used, these techniques were not always consistent or in compliance with recommendations. Furthermore, barrier precautions do

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not prevent most sharps injuries (e.g., puncture or cut wounds); therefore, the occurrences of puncture or cut wounds during treatment may have allowed the dentist's blood to enter an open wound or contact mucous membranes of a patient directly. Objective assessment of sharps injuries, beyond self-reports by the staff and a previous report by the dentist, was not possible (*1*).

Patients A, B, and C had invasive dental procedures performed after the dentist's diagnosis of AIDS, and two of the patients did not receive dental care from this dentist until after he had been diagnosed with AIDS and had evidence of severe immunosuppression (i.e., CD4 lymphocyte count $<200/mm^3$). At this time, higher titers of virus may have been present in the dentist's blood and he may have been more likely to transmit virus than earlier in the course of his HIV disease (*6*).

Transmission might also have occurred by the use of instruments or other dental equipment that had been previously contaminated with blood from either the dentist or a patient already infected by the dentist. The office did not have a written policy for reprocessing dental instruments and equipment and reportedly did not consistently adhere to all recommended guidelines (*7–11*). However, this mode of transmission may be less likely than direct blood-blood transfer during an invasive procedure because HIV is present in blood at low concentrations, does not survive in the environment for extended periods, and has not demonstrated resistance to heat or to commonly used chemical germicides (*7*). The investigation suggested that the instances in which two of the three patients had appointments on the same day may have been chance occurrences. In addition, no invasive procedure was documented for patient B on the day both she and patient A visited the office, and the HIV status of patients A, B, and C is unknown for the days of their shared visits.

The precise risk for HIV transmission to patients during invasive procedures is not known but is most likely very low (*1*). Although AIDS has been recognized in the United States since 1981, the cases described here are the first in which such transmission has been reported.

Guidelines for prevention of transmission of HIV and other bloodborne pathogens in health-care settings have been published by CDC and others (*7–12*); these guidelines promote adherence to universal precautions, including prevention of blood contact between health-care workers and patients, and proper cleaning and sterilization or disinfection of instruments and other patient-care equipment.

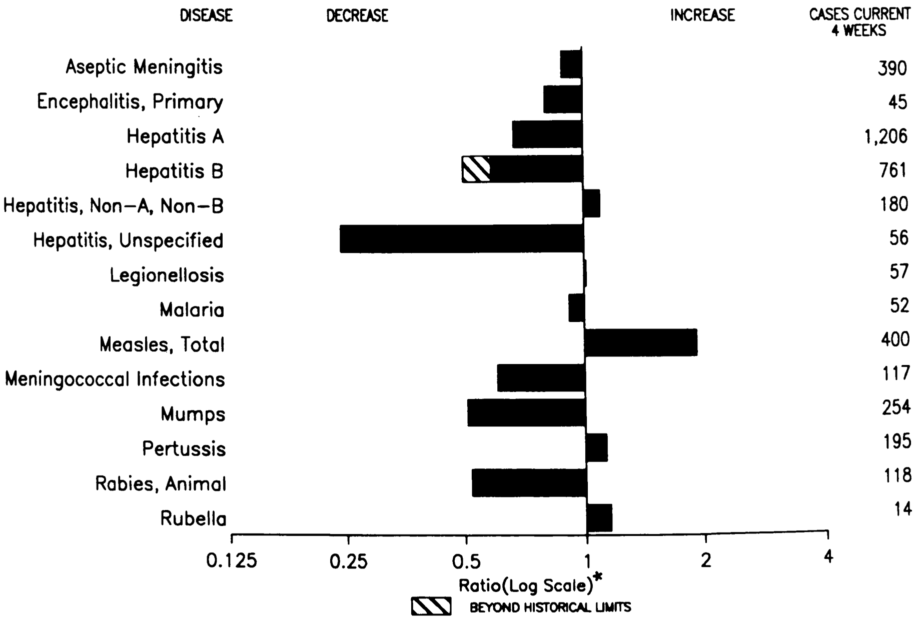
CDC will convene a meeting in Atlanta on February 21–22 to review current information on risks of transmission of HIV and HBV to patients during invasive procedures and to assess the implications of these risks. Information regarding this meeting can be obtained from the meeting organizers, PACE Enterprises, at (404) 633-8610.

References

1. CDC. Possible transmission of human immunodeficiency virus to a patient during an invasive dental procedure. MMWR 1990;39:489–93.
2. Ou CY, Kwok S, Mitchell SW, et al. DNA amplification for direct detection of HIV-1 in DNA of peripheral blood mononuclear cells. Science 1988;239:295–7.
3. Burger H, Gibbs R, Nguyen PN, et al. HIV-1 transmission within a family: generation of viral heterogeneity correlates with duration of infection. In: Brown F, Chanock RM, Ginsberg HS, Lerner RA, eds. Vaccines 90: modern approaches to new vaccines including prevention of AIDS. Cold Spring Harbor, New York: Cold Spring Harbor Laboratory, 1990:255–62.

(Continued on page 33)

FIGURE I. Notifiable disease reports, comparison of 4-week totals ending January 12, 1991, with historical data — United States



*Ratio of current 4-week total to mean of 15 4-week totals (from comparable, previous, and subsequent 4-week periods for past 5 years).

TABLE I. Summary — cases of specified notifiable diseases, United States, cumulative, week ending January 12, 1991 (2nd Week)

	Cum. 1991		Cum. 1991
AIDS	511	Plague	-
Anthrax	-	Poliomyelitis, Paralytic*	-
Botulism: Foodborne	-	Psittacosis	1
Infant	2	Rabies, human	-
Other	-	Syphilis: civilian	1,013
Brucellosis	1	military	1
Cholera	-	Syphilis, congenital, age < 1 year	-
Congenital rubella syndrome	-	Tetanus	-
Diphtheria	-	Toxic shock syndrome	11
Encephalitis, post-infectious	1	Trichinosis	-
Gonorrhea: civilian	15,685	Tuberculosis	562
military	209	Tularemia	3
Leprosy	1	Typhoid fever	1
Leptospirosis	-	Typhus fever, tickborne (RMSF)	3
Measles: imported	2		
indigenous	43		

*No cases of suspected poliomyelitis have been reported in 1991; none of the 6 suspected cases in 1990 have been confirmed to date. Five of the 13 suspected cases in 1989 were confirmed and all were vaccine associated.

TABLE II. Cases of specified notifiable diseases, United States, weeks ending January 12, 1991, and January 13, 1990 (2nd Week)

Reporting Area	AIDS	Aseptic Menin-gitis	Encephalitis		Gonorrhea (Civilian)		Hepatitis (Viral), by type				Legionel-losis	Leprosy
			Primary	Post-in-fectious			A	B	NA,NB	Unspeci-fied		
	Cum. 1991	Cum. 1991	Cum. 1991	Cum. 1991	Cum. 1991	Cum. 1990	Cum. 1991	Cum. 1991	Cum. 1991	Cum. 1991	Cum. 1991	Cum. 1991
UNITED STATES	511	135	13	1	15,685	26,663	482	280	70	25	21	1
NEW ENGLAND	20	8	2	-	599	746	10	21	4	2	3	-
Maine	11	-	1	-	2	9	1	1	1	-	-	-
N.H.	-	-	-	-	-	11	1	2	1	-	1	-
Vt.	3	-	-	-	3	4	-	-	-	-	-	-
Mass.	-	3	1	-	280	204	5	16	2	1	2	-
R.I.	6	5	-	-	35	53	3	2	-	1	-	-
Conn.	-	-	-	-	279	465	-	-	-	-	-	-
MID. ATLANTIC	92	-	-	-	860	2,624	8	5	-	-	-	-
Upstate N.Y.	-	-	-	-	-	229	-	-	-	-	-	-
N.Y. City	2	-	-	-	-	1,493	-	-	-	-	-	-
N.J.	88	-	-	-	236	571	-	-	-	-	-	-
Pa.	2	-	-	-	624	331	8	5	-	-	-	-
E.N. CENTRAL	112	15	1	1	2,347	6,529	21	35	9	4	5	-
Ohio	-	8	-	1	-	2,605	16	21	3	2	4	-
Ind.	-	-	-	-	501	533	-	-	-	-	-	-
Ill.	97	-	-	-	1,052	1,813	-	-	-	-	-	-
Mich.	-	7	1	-	751	1,235	5	13	1	2	1	-
Wis.	15	-	-	-	43	343	-	1	5	-	-	-
W.N. CENTRAL	42	18	1	-	809	1,317	106	5	2	-	2	-
Minn.	28	4	-	-	132	176	-	-	-	-	-	-
Iowa	14	1	-	-	81	188	4	1	-	-	-	-
Mo.	-	-	-	-	382	622	-	-	-	-	-	-
N. Dak.	-	-	-	-	-	16	-	-	-	-	-	-
S. Dak.	-	2	1	-	6	5	82	-	-	-	-	-
Nebr.	-	5	-	-	82	4	17	3	-	-	2	-
Kans.	-	6	-	-	126	306	3	1	2	-	-	-
S. ATLANTIC	84	47	3	-	5,867	8,179	20	71	14	2	1	-
Del.	-	1	-	-	23	72	3	4	1	-	-	-
Md.	-	6	2	-	782	818	6	9	4	1	-	-
D.C.	38	3	-	-	213	449	1	2	-	-	-	-
Va.	21	-	-	-	149	836	1	-	-	-	-	-
W. Va.	3	-	-	-	63	63	2	2	-	1	-	-
N.C.	-	30	-	-	1,164	1,095	3	28	8	-	-	-
S.C.	19	2	-	-	480	1,030	2	25	1	-	1	-
Ga.	2	-	1	-	1,664	1,678	-	1	-	-	-	-
Fla.	1	5	-	-	1,329	2,138	2	-	-	-	-	-
E.S. CENTRAL	11	7	-	-	1,380	1,911	12	28	16	-	2	-
Ky.	-	4	-	-	204	174	3	13	1	-	2	-
Tenn.	11	2	-	-	322	281	5	12	15	-	-	-
Ala.	-	1	-	-	600	1,030	4	3	-	-	-	-
Miss.	-	-	-	-	254	426	-	-	-	-	-	-
W.S. CENTRAL	61	24	3	-	1,401	1,932	26	25	3	-	-	-
Ark.	-	23	-	-	314	401	5	-	-	-	-	-
La.	-	-	-	-	275	437	6	11	-	-	-	-
Okla.	-	1	3	-	162	176	15	14	3	-	-	-
Tex.	61	-	-	-	650	918	-	-	-	-	-	-
MOUNTAIN	-	4	-	-	345	641	104	14	4	1	7	-
Mont.	-	-	-	-	2	6	6	1	-	-	-	-
Idaho	-	-	-	-	2	2	2	1	-	-	-	-
Wyo.	-	-	-	-	3	6	1	-	-	-	-	-
Colo.	-	-	-	-	-	150	2	-	-	1	-	-
N. Mex.	-	-	-	-	34	31	36	1	-	-	-	-
Ariz.	-	-	-	-	208	298	39	5	-	-	2	-
Utah	-	2	-	-	17	20	14	2	2	-	4	-
Nev.	-	2	-	-	79	128	4	4	2	-	1	-
PACIFIC	89	12	3	-	2,077	2,784	175	76	18	16	1	1
Wash.	-	-	-	-	150	307	5	4	-	-	-	-
Oreg.	-	-	-	-	93	125	10	3	-	-	-	-
Calif.	88	12	3	-	1,799	2,295	157	69	18	16	1	1
Alaska	1	-	-	-	30	51	1	-	-	-	-	-
Hawaii	-	-	-	-	5	6	2	-	-	-	-	-
Guam	-	-	-	-	-	8	-	-	-	-	-	-
P.R.	-	-	-	-	-	67	-	-	-	-	-	-
V.I.	-	-	-	-	-	16	-	-	-	-	-	-
Amer. Samoa	-	-	-	-	-	4	-	-	-	-	-	-
C.N.M.I.	-	-	-	-	-	3	-	-	-	-	-	-

N: Not notifiable U: Unavailable C.N.M.I.: Commonwealth of the Northern Mariana Islands

TABLE II. (Cont'd.) Cases of specified notifiable diseases, United States, weeks ending January 12, 1991, and January 13, 1990 (2nd Week)

Reporting Area	Malaria	Measles (Rubeola)					Menin-gococcal Infections	Mumps		Pertussis			Rubella		
		Indigenous		Imported*		Total									
	Cum. 1991	1991	Cum. 1991	1991	Cum. 1991	Cum. 1990	Cum. 1991	1991	Cum. 1991	1991	Cum. 1991	Cum. 1990	1991	Cum. 1991	Cum. 1990
UNITED STATES	13	19	43	2	2	466	31	30	55	20	44	100	3	5	18
NEW ENGLAND	2	-	-	-	-	4	4	1	1	1	6	12	-	-	-
Maine	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-
N.H.	-	-	-	-	-	-	2	-	-	-	5	-	-	-	-
Vt.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mass.	1	-	-	-	-	-	2	-	-	-	-	11	-	-	-
R.I.	1	-	-	-	-	-	-	1	1	-	-	-	-	-	-
Conn.	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-
MID. ATLANTIC	-	-	-	-	-	22	1	6	6	5	5	7	-	-	-
Upstate N.Y.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N.Y. City	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N.J.	-	-	-	-	-	6	-	-	-	-	-	5	-	-	-
Pa.	-	-	-	-	-	16	1	6	6	5	5	2	-	-	-
E.N. CENTRAL	-	-	-	-	-	321	-	6	6	2	8	49	-	-	3
Ohio	-	-	-	-	-	-	-	-	-	1	7	-	-	-	-
Ind.	-	-	-	-	-	3	-	-	-	-	-	26	-	-	-
Ill.	-	-	-	-	-	112	-	-	-	-	-	7	-	-	3
Mich.	-	-	-	-	-	76	-	6	6	1	1	2	-	-	-
Wis.	-	-	-	-	-	130	-	-	-	-	-	14	-	-	-
W.N. CENTRAL	-	-	-	-	-	26	1	2	5	7	8	2	1	1	-
Minn.	-	-	-	-	-	-	-	1	1	5	5	1	1	1	-
Iowa	-	-	-	-	-	18	-	1	1	1	1	-	-	-	-
Mo.	-	-	-	-	-	8	-	-	-	-	1	-	-	-	-
N. Dak.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S. Dak.	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Nebr.	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-
Kans.	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
S. ATLANTIC	-	1	1	-	-	6	6	12	21	-	-	5	-	2	-
Del.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Md.	-	-	-	-	-	5	-	11	16	-	-	-	-	2	-
D.C.	-	-	-	-	-	-	-	-	3	-	-	1	-	-	-
Va.	-	-	-	-	-	1	-	-	1	-	-	1	-	-	-
W. Va.	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-
N.C.	-	-	-	-	-	-	3	-	-	-	-	3	-	-	-
S.C.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ga.	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Fla.	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-
E.S. CENTRAL	1	-	-	-	-	11	5	1	1	-	1	7	-	-	-
Ky.	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Tenn.	-	-	-	-	-	8	1	-	-	-	1	1	-	-	-
Ala.	1	-	-	-	-	-	3	1	1	-	-	6	-	-	-
Miss.	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
W.S. CENTRAL	-	-	-	1	1	-	2	-	-	-	1	1	-	-	-
Ark.	-	-	-	1§	1	-	-	-	-	-	-	-	-	-	-
La.	-	-	-	-	-	-	2	-	-	-	1	1	-	-	-
Okla.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tex.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOUNTAIN	-	1	3	-	-	6	2	-	2	3	6	3	1	1	-
Mont.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Idaho	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wyo.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Colo.	-	-	-	-	-	-	-	-	1	-	3	-	-	-	-
N. Mex.	-	-	-	-	-	-	-	N	N	1	1	-	-	-	-
Ariz.	-	1	1	-	-	6	2	-	1	2	2	2	-	-	-
Utah	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Nev.	-	-	2	-	-	-	-	-	-	-	-	-	1	1	-
PACIFIC	10	17	39	1	1	70	10	2	13	2	9	14	1	1	15
Wash.	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Oreg.	1	-	-	-	-	-	2	N	N	-	-	4	-	-	-
Calif.	9	17	38	1§	1	69	8	1	10	2	4	10	1	1	13
Alaska	-	-	-	-	-	-	-	1	2	-	-	-	-	-	-
Hawaii	-	-	1	-	-	-	-	-	1	-	5	-	-	-	2
Guam	-	U	-	U	-	-	-	U	-	U	-	-	U	-	-
P.R.	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
V.I.	-	U	-	U	-	-	-	U	-	U	-	-	U	-	-
Amer. Samoa	-	U	-	U	-	-	-	U	-	U	-	-	U	-	-
C.N.M.I.	-	U	-	U	-	-	-	U	-	U	-	-	U	-	-

*For measles only, imported cases includes both out-of-state and international importations.

N: Not notifiable U: Unavailable †International §Out-of-state

TABLE II. (Cont'd.) Cases of specified notifiable diseases, United States, weeks ending January 12, 1991, and January 13, 1990 (2nd Week)

Reporting Area	Syphilis (Civilian) (Primary & Secondary)		Toxic-shock Syndrome	Tuberculosis		Tula-remia	Typhoid Fever	Typhus Fever (Tick-borne) (RMSF)	Rabies, Animal
	Cum. 1991	Cum. 1990	Cum. 1991	Cum. 1991	Cum. 1990	Cum. 1991	Cum. 1991	Cum. 1991	Cum. 1991
UNITED STATES	1,013	1,274	11	562	543	3	1	3	67
NEW ENGLAND	36	88	1	7	1	-	-	-	-
Maine	-	-	-	-	-	-	-	-	-
N.H.	-	23	-	-	1	-	-	-	-
Vt.	-	-	-	-	-	-	-	-	-
Mass.	27	16	1	-	-	-	-	-	-
R.I.	-	-	-	2	-	-	-	-	-
Conn.	9	49	-	5	-	-	-	-	-
MID. ATLANTIC	106	274	-	105	176	-	-	-	23
Upstate N.Y.	-	3	-	-	2	-	-	-	3
N.Y. City	-	200	-	86	147	-	-	-	-
N.J.	51	66	-	13	12	-	-	-	20
Pa.	55	5	-	6	15	-	-	-	-
E.N. CENTRAL	155	66	3	66	61	-	-	-	1
Ohio	-	12	3	29	-	-	-	-	-
Ind.	18	1	-	1	-	-	-	-	-
Ill.	126	32	-	35	56	-	-	-	-
Mich.	4	4	-	-	-	-	-	-	-
Wis.	7	17	-	1	5	-	-	-	1
W.N. CENTRAL	21	15	2	7	16	1	-	-	5
Minn.	3	5	1	-	6	-	-	-	5
Iowa	1	1	1	6	1	-	-	-	-
Mo.	17	8	-	-	2	-	-	-	-
N. Dak.	-	1	-	1	3	-	-	-	-
S. Dak.	-	-	-	-	2	-	-	-	-
Nebr.	-	-	-	-	2	-	-	-	-
Kans.	-	-	-	-	-	1	-	-	-
S. ATLANTIC	342	508	1	21	53	-	-	2	28
Del.	2	7	-	-	4	-	-	-	3
Md.	31	45	-	4	12	-	-	-	11
D.C.	24	-	-	3	-	-	-	-	-
Va.	13	46	-	-	9	-	-	-	4
W. Va.	-	-	-	5	2	-	-	-	2
N.C.	32	43	1	-	-	-	-	2	-
S.C.	37	53	-	9	19	-	-	-	2
Ga.	88	127	-	-	-	-	-	-	6
Fla.	115	187	-	-	7	-	-	-	-
E.S. CENTRAL	40	80	-	42	14	-	-	1	-
Ky.	1	-	-	-	8	-	-	-	-
Tenn.	1	-	-	-	-	-	-	-	-
Ala.	20	47	-	16	6	-	-	1	-
Miss.	18	33	-	26	-	-	-	-	-
W.S. CENTRAL	135	96	1	46	70	1	-	-	6
Ark.	9	14	-	-	19	1	-	-	3
La.	70	61	-	46	51	-	-	-	-
Okla.	4	5	1	-	-	-	-	-	3
Tex.	52	16	-	-	-	-	-	-	-
MOUNTAIN	24	13	-	36	4	-	-	-	1
Mont.	-	-	-	-	-	-	-	-	-
Idaho	-	1	-	-	-	-	-	-	-
Wyo.	1	-	-	-	-	-	-	-	-
Colo.	-	4	-	6	-	-	-	-	-
N. Mex.	-	-	-	-	2	-	-	-	-
Ariz.	23	7	-	20	-	-	-	-	1
Utah	-	1	-	10	-	-	-	-	-
Nev.	-	-	-	-	2	-	-	-	-
PACIFIC	154	134	3	232	148	1	1	-	3
Wash.	-	18	-	5	11	-	-	-	-
Oreg.	-	1	-	-	4	-	-	-	-
Calif.	153	114	3	221	117	1	1	-	3
Alaska	1	1	-	1	4	-	-	-	-
Hawaii	-	-	-	5	12	-	-	-	-
Guam	-	-	-	-	1	-	-	-	-
P.R.	-	25	-	-	-	-	-	-	-
V.I.	-	-	-	-	-	-	-	-	-
Amer. Samoa	-	-	-	-	-	-	-	-	-
C.N.M.I.	-	-	-	-	2	-	-	-	-

U: Unavailable

TABLE III. Deaths in 121 U.S. cities,* week ending January 12, 1991 (2nd Week)

Reporting Area	All Causes, By Age (Years)						P&I**
	All Ages	≥65	45-64	25-44	1-24	<1	Total
NEW ENGLAND	709	484	134	51	17	23	65
Boston, Mass.	193	118	42	18	7	8	19
Bridgeport, Conn.	46	29	10	5	2	-	7
Cambridge, Mass.	25	24	1	-	-	-	5
Fall River, Mass.	32	24	6	1	-	1	1
Hartford, Conn.	74	43	19	7	2	3	1
Lowell, Mass.	32	23	4	4	1	-	5
Lynn, Mass.	12	5	2	5	-	-	2
New Bedford, Mass.	28	21	5	2	-	-	1
New Haven, Conn.	48	32	11	1	-	4	4
Providence, R.I.	38	33	2	-	2	1	2
Somerville, Mass.	8	4	4	-	-	-	1
Springfield, Mass.	62	44	15	1	-	2	6
Waterbury, Conn.	42	35	4	2	-	1	4
Worcester, Mass.	69	49	9	5	3	3	7
MID. ATLANTIC	3,388	2,190	632	357	91	118	226
Albany, N.Y.	56	35	9	7	2	3	8
Allentown, Pa.	29	24	2	2	1	-	3
Buffalo, N.Y.	100	70	20	6	1	3	5
Camden, N.J.	43	24	11	5	1	2	-
Elizabeth, N.J.	36	28	5	3	-	-	8
Erie, Pa.†	46	33	9	3	1	-	7
Jersey City, N.J.	67	53	9	5	-	-	7
N.Y. City, N.Y.	1,954	1,218	380	246	61	49	103
Newark, N.J.	77	26	21	20	6	4	10
Paterson, N.J.	54	33	9	4	2	6	4
Philadelphia, Pa.	394	252	68	26	9	39	23
Pittsburgh, Pa.†	74	48	16	5	1	4	7
Reading, Pa.	46	38	7	1	-	-	7
Rochester, N.Y.	131	99	18	8	2	4	9
Schenectady, N.Y.	33	27	4	-	1	1	2
Scranton, Pa.†	30	22	5	3	-	-	-
Syracuse, N.Y.	119	83	24	8	2	2	16
Trenton, N.J.	47	30	12	4	-	1	3
Utica, N.Y.	22	19	1	1	1	-	1
Yonkers, N.Y.	30	28	2	-	-	-	3
E.N. CENTRAL	3,330	2,333	581	183	91	142	179
Akron, Ohio	73	55	11	2	2	3	-
Canton, Ohio	42	31	9	1	1	-	7
Chicago Ill	1,159	873	139	26	38	83	34
Cincinnati, Ohio	171	115	34	11	3	8	22
Cleveland, Ohio	152	95	34	16	2	5	2
Columbus, Ohio	214	141	50	10	8	5	4
Dayton, Ohio	138	99	23	9	2	5	6
Detroit, Mich.	314	172	78	42	12	10	11
Evansville, Ind.	55	37	14	3	-	1	3
Fort Wayne, Ind.	89	60	17	8	3	1	4
Gary, Ind.	25	15	5	4	-	1	1
Grand Rapids, Mich.	49	40	5	2	1	1	8
Indianapolis, Ind.	258	175	53	16	9	5	23
Madison, Wis.	27	18	5	3	-	1	3
Milwaukee, Wis.	193	138	32	12	5	6	21
Peoria, Ill.	67	49	13	3	-	2	9
Rockford, Ill.	51	37	11	2	-	1	2
South Bend, Ind.	55	43	6	5	1	-	5
Toledo, Ohio	132	90	29	7	3	3	7
Youngstown, Ohio	66	50	13	1	1	1	7
W.N. CENTRAL	914	666	148	50	22	27	58
Des Moines, Iowa	86	70	11	2	2	1	6
Duluth, Minn.	31	21	6	2	-	2	2
Kansas City, Kans.	45	32	6	3	3	-	-
Kansas City, Mo.	58	35	14	4	2	3	7
Lincoln, Nebr.	41	30	5	1	3	2	6
Minneapolis, Minn.	194	149	28	12	2	3	13
Omaha, Nebr.	114	76	21	5	5	7	2
St. Louis, Mo.	191	142	27	15	1	6	12
St. Paul, Minn.	74	56	15	2	1	-	6
Wichita, Kans.	80	55	15	4	3	3	4

Reporting Area	All Causes, By Age (Years)						P&I**
	All Ages	≥65	45-64	25-44	1-24	<1	Total
S. ATLANTIC	1,473	892	314	161	54	49	94
Atlanta, Ga.	224	126	53	32	8	5	8
Baltimore, Md.	298	176	76	29	13	4	27
Charlotte, N.C.	80	51	20	7	2	-	5
Jacksonville, Fla.	150	97	33	9	6	5	23
Miami, Fla.	203	108	44	37	8	6	1
Norfolk, Va.	66	38	12	7	5	4	4
Richmond, Va.	97	67	18	7	2	3	7
Savannah, Ga.	48	23	6	7	5	7	2
St. Petersburg, Fla.	80	59	9	5	1	6	2
Tampa, Fla.	211	133	41	21	4	9	15
Washington, D.C.§	U	U	U	U	U	U	U
Wilmington, Del.	16	14	2	-	-	-	-
E.S. CENTRAL	597	404	118	44	21	10	39
Birmingham, Ala.§	U	U	U	U	U	U	U
Chattanooga, Tenn.	98	73	12	11	2	-	8
Knoxville, Tenn.	48	32	12	3	1	-	3
Louisville, Ky.	79	52	15	2	5	5	6
Memphis, Tenn.	161	103	32	16	9	1	7
Mobile, Ala.	45	31	11	3	-	-	2
Montgomery, Ala.§	U	U	U	U	U	U	U
Nashville, Tenn.	166	113	36	9	4	4	13
W.S. CENTRAL	1,722	1,076	362	164	70	50	88
Austin, Tex.	71	50	11	6	3	1	2
Baton Rouge, La.	49	30	12	5	1	1	2
Corpus Christi, Tex.	74	52	17	-	1	4	5
Dallas, Tex.	259	146	51	32	18	12	3
El Paso, Tex.	90	63	18	8	1	-	5
Fort Worth, Tex.	144	87	33	7	11	6	5
Houston, Tex.	437	250	102	53	19	13	49
Little Rock, Ark.	87	61	15	8	3	-	2
New Orleans, La.	100	58	22	16	-	4	-
San Antonio, Tex.	229	152	42	19	11	5	2
Shreveport, La.	50	38	7	2	-	3	1
Tulsa, Okla.	132	89	32	8	2	1	12
MOUNTAIN	945	652	181	67	18	27	56
Albuquerque, N. Mex.	102	73	16	10	2	1	5
Colo. Springs, Colo.	45	31	10	2	1	1	6
Denver, Colo.	185	125	32	17	3	8	13
Las Vegas, Nev.	217	149	51	10	1	6	10
Ogden, Utah	26	18	3	5	-	-	4
Phoenix, Ariz.	148	106	24	6	6	6	9
Pueblo, Colo.	26	18	7	1	-	-	1
Salt Lake City, Utah	45	26	8	8	1	2	4
Tucson, Ariz.	151	106	30	8	4	3	4
PACIFIC	2,284	1,565	376	222	59	55	140
Berkeley, Calif.	15	13	2	-	-	-	-
Fresno, Calif.§	U	U	U	U	U	U	U
Glendale, Calif.	24	21	3	-	-	-	3
Honolulu, Hawaii	116	80	28	3	3	2	6
Long Beach, Calif.	117	80	20	10	3	4	18
Los Angeles Calif.	597	389	88	84	28	3	19
Oakland, Calif.§	U	U	U	U	U	U	U
Pasadena, Calif.	38	28	6	3	-	1	7
Portland, Oreg.	182	134	32	9	1	6	12
Sacramento, Calif.	198	136	25	24	7	6	24
San Diego, Calif.	161	105	24	18	4	8	7
San Francisco, Calif.	223	139	41	34	3	6	13
San Jose, Calif.	253	176	46	17	4	10	21
Seattle, Wash.	197	152	28	11	1	5	6
Spokane, Wash.	55	48	2	3	-	2	2
Tacoma, Wash.	108	64	31	6	5	2	2
TOTAL	15,362††	10,262	2,846	1,299	443	501	945

*Mortality data in this table are voluntarily reported from 121 cities in the United States, most of which have populations of 100,000 or more. A death is reported by the place of its occurrence and by the week that the death certificate was filed. Fetal deaths are not included.
**Pneumonia and influenza.
†Because of changes in reporting methods in these 3 Pennsylvania cities, these numbers are partial counts for the current week. Complete counts will be available in 4 to 6 weeks.
††Total includes unknown ages.
§Report for this week is unavailable (U).

HIV — Continued

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Tornado Disaster — Illinois, 1990

On August 28, 1990, from 3:15 to 3:45 p.m., the strongest tornado in northern Illinois in >20 years struck the towns of Plainfield, Crest Hill, and Joliet in Will County. As a result of the storm's impact phase, 302 persons were injured (28 fatally). This report summarizes an investigation of injuries and deaths that resulted from the tornado's impact.

The tornado's path was up to ½-mile wide and 16.5 miles long; wind speeds were >260 mph. National Weather Service criteria for issuing a tornado warning were not satisfied until the tornado had already touched the ground. Electrical power service to 65,000 customers and phone service to 10,000 residences were severed; in addition, the tornado destroyed three schools, a church, many businesses, 106 apartment units, and 470 single-family dwellings. The estimated cost of damages was $200 million (Will County Emergency Services Disaster Agency, unpublished data, 1990). Because no warning was provided, few persons sought a tornado shelter.

The investigation included a review of 350 emergency-room and inpatient medical records from eight hospitals to identify injuries sustained during the impact phase and the postimpact phase of the tornado. Ninety percent of affected persons were white and lived in predominantly residential subdivisions in three communities (*1*). Because many persons who were rendered homeless by the tornado relocated with relatives living in the area, more than 84% of the victims who sought medical care at hospitals could be contacted for telephone interviews.

An impact-related injury or death was defined as an injury or death caused by the direct mechanical effects of the tornado. Postimpact injuries were defined as injuries that would not have occurred in the absence of the tornado and that occurred within a 48-hour period following the tornado (e.g., from walking through the debris or cleaning up debris).

While most impact-related deaths occurred instantaneously, four persons with impact-related injuries died 2–8 weeks after the tornado. Of these four, one man died 8 weeks later from complications of chest trauma suffered during the impact phase.

Tornado Disaster — Continued

Most (221 [63%] of 350) victims were treated initially at one of the eight hospitals; several of the more severely injured were transferred to tertiary-care facilities in other areas. Because the disaster occurred simultaneously with the change of work shifts for the nursing staff, approximately twice as many persons were available as would be expected in an average staffing pattern for that hospital; many physicians and off-duty nurses also volunteered services.

Of the 28 persons who died from impact-related injuries, eight were <20 years of age (range: 1 month–69 years; mean: 34 years); 14 were male (Table 1). Seven persons died in one large apartment complex; eight, in vehicles; five, in schools; four, in houses; and two, outside. Three persons died at one high school, where ≥10 students crouched against the only hallway wall that did not collapse and, therefore, may have been protected from fatal or severe injury.

Reported by: Staffs of the following hospitals: St. Joseph Medical Center, Silver Cross Hospital, Joliet; Loyola Univ Medical Center, Maywood; Christ Hospital and Medical Center, Oak Lawn; Copley Memorial Hospital, Aurora; Edward Hospital, Naperville; Palos Community Hospital, Palos Heights; Morris Hospital, Morris. R Empereur, G Wold, Will County Health Dept; D Krieger, J Sapala, MD, Will County Coroner's Office; Illinois Emergency Svcs Disaster Agency; ML England, MS, BJ Francis, MD, State Epidemiologist, Illinois Dept of Public Health. Disaster Health Svcs, American Red Cross, Washington, DC. Health Studies Br, Div of Environmental Hazards and Health Effects, Center for Environmental Health and Injury Control, CDC.

Editorial Note: Tornadoes are one of the most lethal and violent of all natural atmospheric phenomena (*2*). Tornadoes usually appear as rotating, funnel-shaped

TABLE 1. Characteristics of persons who died or who sought medical care as a result of tornado impact-related injuries, by sex, age, and where injury occurred — Will County, Illinois, August 28, 1990

	Treated and released (n=194)		Hospitalized (n=85)		Fatally injured (n=28)*	
Category	**No.**	**(%)**	**No.**	**(%)**	**No.**	**(%)**
Sex						
Female	101	(52.1)	40	(47.1)	14	(50.0)
Male	93	(47.9)	45	(52.9)	14	(50.0)
Age (yrs)						
<20	76	(39.2)	29	(34.1)	8	(28.6)
20–40	59	(30.4)	25	(29.4)	10	(35.7)
41–64	34	(17.5)	20	(23.5)	6	(21.4)
≥65	15	(7.7)	11	(12.9)	4	(14.3)
Unknown	10	(5.2)	0		0	
Where injury occurred						
Apartment	19	(9.8)	8	(9.4)	7	(25.0)
Mobile home	0		1	(1.2)	0	
Office	3	(1.5)	4	(4.7)	0	
Other building	4	(2.1)	3	(3.5)	0	
Other workplace	13	(6.7)	4	(4.7)	5	(17.9)
Outside	4	(2.1)	2	(2.4)	2	(7.1)
Single-family home	82	(42.3)	38	(44.7)	4	(14.3)
Vehicle	32	(16.5)	22	(25.9)	8	(28.6)
Unknown	37	(19.1)	3	(3.5)	2	(7.1)

*Includes five hospitalized patients.

Tornado Disaster — Continued

clouds that extend toward the ground from the base of thunderclouds with whirling winds of high velocity. The wind clouds rotate around a hollow cavity in which centrifugal forces produce a partial vacuum (*3*). Severe tornadoes may be >0.6 miles wide, travel as far as 185 miles, and attain wind speeds of up to 310 mph. In the United States, the frequency of tornadoes varies by season: most occur from April through July during the late afternoon. Each year, almost 700 tornadoes occur in the United States; however, only about 3% result in casualties (*3*). Since 1950, tornado-related deaths have declined substantially because of improved warning systems and public response to warnings. Nevertheless, from 1953 through 1989, 3522 persons died as a result of tornadoes in the United States (*4*).

The tornado in Will County was atypical for several reasons. First, it was not characterized by a classic funnel appearance; instead, eyewitnesses described it as having a wall-like appearance. Second, it occurred in late August; 75% of tornadoes and almost all tornado-related fatalities occur by late July. Third, the Will County tornado approached from northwest to southeast; most tornadoes follow a southwest to northeast path (*5*). Fourth, it did not weaken or leave the ground for the entire 16.4 miles of its path. Finally, this tornado attained a rating of 5 on the Fujita scale—the maximum intensity for a tornado; based on this rating, the Will County tornado is among the highest 3% of the most violent tornadoes in U.S. history.

Because the tornado developed extremely rapidly, it was not detected by the conventional radar systems in use; a more sensitive Doppler radar was not in use because of a previous malfunction. The affected area was served by two emergency warning sirens; however, because official tornado spotters had not observed funnel clouds, the sirens were sounded only after the tornado began its destructive course through the town of Plainfield. A new radar system (NEXRAD [Next Generation Weather Radar]) to be installed in this area in 1992 uses Doppler and computer technology; tornado forecasting accuracy is expected to increase 66%.

Based on studies of previous tornadoes, persons aged >60 years are seven times more likely to be injured than persons aged <20 years because of factors such as medical illnesses, decreased mobility, decreased ability to comprehend and rapidly act on tornado warnings, and greater susceptibility to injury (*6*). In Will County, the relatively higher proportion of deaths and injuries among persons <20 years of age (37.9%) than among those >65 years (9.7%) may reflect both the population at risk (primarily a suburban, family-oriented community, with a median age of 27.5 years), the time of day (3:15 p.m., when homemakers and young children are at home), and the absence of warning. Compared with minor injuries, the risk for death may have been greater for persons aged >65 years than for those aged <20 years (odds ratio = 2.5; 95% confidence interval = 0.5–10.9).

Based on previous studies, recommendations to reduce the risk for injury include seeking shelter indoors in the basement, on the lowest floor, or in a centrally located room; identifying shelters before a disaster; and using blankets or other materials for protection from flying objects (*6–10*). In addition, tornado-related morbidity and mortality may be reduced by 1) instituting improved early warning systems and methods of detecting tornadoes in all highly tornado-prone areas; 2) constructing tornado-resistant buildings or shelters; and 3) promoting behaviors that maximize the possibility of survival when a tornado strikes.

Tornado Disaster — Continued

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Measles Vaccination Levels among Selected Groups of Preschool-Aged Children — United States

In 1989 and 1990, the incidence of measles increased dramatically among preschool-aged children in inner cities (*1*). The largest outbreaks occurred primarily among unvaccinated black and Hispanic children in large cities (e.g., Chicago [*2*], Dallas, Houston, Los Angeles, Milwaukee, and New York). However, measles outbreaks have not occurred in all large U.S. cities; differences in vaccine coverage could account for these variations. This report describes surveys of vaccination levels among nonrandomly selected first- and fifth-grade students in Boston, part of New York City (Bronx), Cleveland, Houston, Jersey City, Philadelphia, Pittsburgh, and Seattle.

In May 1990, CDC and public health officials determined vaccine coverage in preschool-aged children in eight cities with differing incidences of measles during the 1980s. School records of first and fifth graders were reviewed in each city (the number of records for each grade by city ranged from 680 to 1460); completion of measles vaccination by the second birthday was the primary measure of vaccination coverage. Local officials selected the schools surveyed. Schools were classified as public or private; inner-city* or noninner-city; and black, white, or Hispanic if one of these racial/ethnic groups accounted for >75% of the students (the remaining schools were classified as mixed). In grades with <60 students, all records were reviewed; in grades with ≥60 students, systematic samples of records were reviewed.

Crude measles vaccine coverage levels by the second birthday ranged from 50% in both first and fifth graders selected in Jersey City to almost 90% among both groups selected in Pittsburgh (Figure 1). Within each city, the percentage of children in the first grade who were vaccinated against measles by the second birthday was similar to or higher than that of children in the fifth grade.

*The definition of inner-city school varied by location.

Measles Vaccination — Continued

Among first-grade students in each of the seven cities in which both private and public schools were surveyed, the percentage of children who were vaccinated by the second birthday was greater in private schools. The differences were statistically significant for all areas except Bronx and Seattle. In five of the six cities in which schools in noninner-city areas were surveyed, the percentage of children who were vaccinated was greater in noninner-city than in inner-city schools (Table 1).

Within inner-city public schools in the same cities, measles vaccination levels among first-grade students at black, Hispanic, and mixed schools were similar (Table 2). However, levels varied substantially among the different cities. For example, 47% of first graders attending predominantly black schools in Jersey City were vaccinated by the second birthday, compared with 79% in Pittsburgh. In two of the three cities with predominantly white schools, first graders in white schools had higher vaccine coverage levels than first graders in other schools.

Overall, in inner-city public schools, the percentage of children vaccinated by the second birthday ranged from 51% in Jersey City to 79% in Pittsburgh. Using data from the first-grade students, an inverse relation was observed between the mean measles incidence during 1980–1989 and measles vaccine coverage levels by the second birthday (Figure 2).

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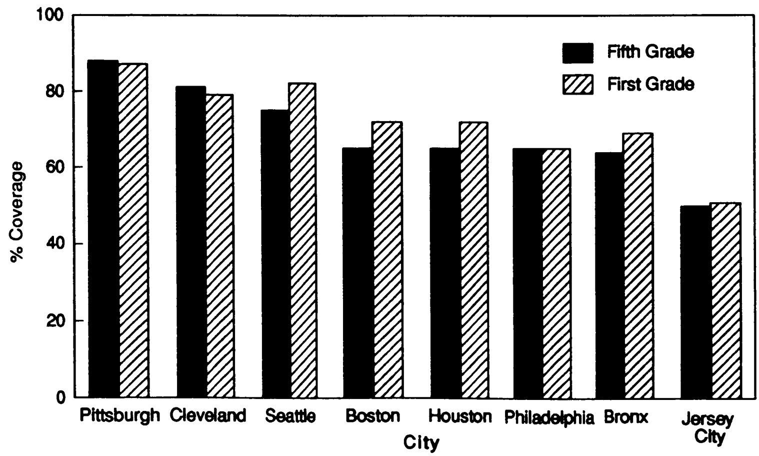
Editorial Note: Although measles vaccination levels are >98% among school-aged children in the United States, levels are lower among preschool-aged children (*3*). Routine national surveys do not monitor vaccination levels among this age group. Before 1986, data on vaccination levels among preschool-aged children were obtained from the United States Immunization Survey (CDC, unpublished data, 1987)

FIGURE 1. Percentage of first- and fifth-grade students who were vaccinated against measles by the second birthday* — United States, 1990



*Based on data from retrospective school-based record reviews.

Measles Vaccination — Continued

and indicated that 82% of children had been vaccinated by the second birthday. However, this earlier survey provided only aggregate data.

The retrospective surveys described in this report were conducted to explore whether the differences observed in measles incidence rates throughout the 1980s in selected cities were reflected in the measles vaccination levels and to determine the feasibility of conducting more definitive retrospective surveys in selected cities. Such surveys are convenient to perform because school vaccination records can be reviewed easily. However, the data provide a measure of vaccination levels in previous periods. For example, the vaccination levels of the first- and fifth-grade students in 1990 reflect levels among 2-year-old children approximately 4 years (1986) and 8 years (1982) before the surveys, respectively. An additional limitation of this study was the nonsystematic selection criteria of schools in the cities. Therefore, inter-city comparisons of vaccination levels should be interpreted with caution.

TABLE 1. Number of student records reviewed and percentage of first-grade students who were vaccinated against measles by the second birthday, by type and location of school — United States, 1990

	Type of school				School location*			
	Public		Private		Inner city		Noninner city	
City	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Boston	749	(71)	107	(82)	617	(71)	239	(76)
Bronx	838	(68)	133	(71)	971	(69)	—†	
Cleveland	1017	(76)	315	(87)	1016	(79)	316	(79)
Houston	517	(60)	399	(89)	594	(62)	322	(91)
Jersey City	1459	(51)	—§		1459	(51)	—†	
Philadelphia	978	(63)	131	(78)	804	(63)	305	(71)
Pittsburgh	1217	(86)	126	(94)	743	(81)	600	(94)
Seattle	640	(82)	176	(83)	558	(77)	258	(85)

*Defined differently in each city.
†Noninner-city schools not surveyed.
§Private schools not surveyed.

TABLE 2. Number of student records reviewed and percentage of first-grade students attending inner-city public schools who were vaccinated against measles by the second birthday, by racial/ethnic classification* of school attended — United States, 1990

	School classification							
	Black		Mixed		Hispanic		White	
City	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Boston	—		499	(69)	—		35	(80)
Bronx	211	(67)	567	(69)	60	(65)	—	
Cleveland	281	(73)	420	(76)	—		—	
Houston	165	(61)	—		292	(55)	60	(80)
Jersey City	445	(47)	885	(53)	129	(51)	—	
Philadelphia	358	(65)	278	(59)	—		97	(54)
Pittsburgh	531	(79)	181	(83)	—		—	
Seattle	—		204	(79)	—		—	

*Defined as >75% of students of racial/ethnic group.

Measles Vaccination — Continued

Despite these limitations, the race-specific data suggest that measles vaccine coverage is suboptimal among black and Hispanic children, who will be at high risk for measles unless coverage can be improved. In addition, the differing levels of coverage among children in these cities suggest that the success of vaccination programs varies.

Local surveys (*2*) and data from the nonrandom surveys in this report confirm low vaccination levels in some U.S. cities. However, these surveys indicate that, at least in the schools surveyed, vaccination levels did not decrease during 1982–1986; whether vaccination levels have declined since 1986 is not known. Regardless, levels in the mid-1980s were low enough to sustain measles outbreaks. The reason for the increase in large outbreaks in inner cities in 1989 and 1990 is not known but may have resulted in part from the large increase in measles activity in many neighboring countries in North and Central America (*4*).

CDC has begun an Infant Immunization Initiative to improve vaccination levels among preschool-aged children in the United States. Effective strategies to vaccinate preschool-aged children are needed to reach national and global objectives for children's health by the year 2000.

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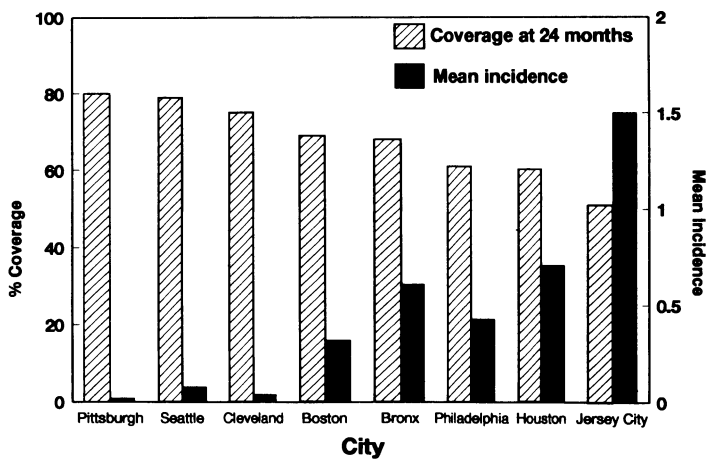
FIGURE 2. Percentage of children who were vaccinated against measles by the second birthday* and mean measles incidence† — United States



*Based on retrospective survey of first-grade students in inner-city public schools.
†Per 100,000 children, 1980–1989.

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The data in this report are provisional, based on weekly reports to CDC by state health departments. The reporting week concludes at close of business on Friday; compiled data on a national basis are officially released to the public on the succeeding Friday. Accounts of interesting cases, outbreaks, environmental hazards, or other public health problems of current interest to health officials, as well as matters pertaining to editorial or other textual considerations should be addressed to: Editor, *Morbidity and Mortality Weekly Report*, Mailstop C-08, Centers for Disease Control, Atlanta, Georgia 30333; telephone (404) 332-4555.

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