Disease Detectives Div. C National Science Olympiad May 31, 2008
Problem I: DISEASE DETECTIVES TACKLE GLOBAL WARMING
Total Suggested time =30 minutes

Most scientists agree that the world's climate is changing. The effects of climate change are likely to include more variable weather, heat waves, heavy precipitation, flooding, droughts, more intense tornadoes and hurricanes, sea level rise, and air pollution. Each of these changes has the potential to affect health negatively. Although our understanding of the effects of climate change is still emerging, climate change has the potential to impact health in many ways. While some of the effects are unpredictable, considerable evidence, such as shrinking of glaciers, lengthening of growing seasons, and earlier flowering of trees supports other effects.[1] Disease detectives (or epidemiologists) are public health professionals who study the distribution and causes of health problems in specified populations and apply this knowledge to control health problems. Disease detectives can help identify locations and population groups at greatest risk for specific health threats, such as heat waves. The following event describes a public health investigation of heat-related deaths during a heat wave in Chicago in 1995.

According to author Eric Klinenberg, "On the first day of the heat wave, Thursday, July 13, the temperature hit 106 degrees, and the heat index—a combination of heat and humidity that measures the temperature a typical person would feel—rose above 120. For a week, the heat persisted, running between the 90s and low 100s. The night temperatures, in the low to mid-80s, were unusually high and didn't provide much relief. Chicago's houses and apartment buildings baked like ovens. The city set new records for energy use, which then led to the failure of some power grids—at one point, 49,000 households had no electricity. Many Chicagoans swarmed the city's beaches, but others took to the fire hydrants. More than 3,000 hydrants around Chicago were opened, causing some neighborhoods to lose water pressure on top of losing electricity. When emergency crews came to seal the hydrants, some people threw bricks and rocks to keep them away. The heat made the city's roads buckle. Train rails warped, causing long commuter and freight delays. City workers watered bridges to prevent them from locking when the plates expanded. Children riding in school buses became so dehydrated and nauseous that they had to be hosed down by the Fire Department. Hundreds of young people were hospitalized with heat-related illnesses. But the elderly, and especially the elderly who lived alone, were most vulnerable to the heat wave.[2] In addition to dying from overheating (hyperthermia), previous studies suggested that heat waves led to an increased number of deaths from cardiovascular disease.

Although the exact number of persons who died because of the 1995 Chicago heat wave might never be known, Disease detectives launched a number of investigations to determine risk factors for death due to this heat wave.

1. **(4 pts)** Disease detectives typically conduct investigations to determine the cause of a particular problem. In this instance, however, the cause was fairly obvious and a study was unnecessary for that purpose. Give two reasons why disease detectives studied this problem. **2 pts each. Answers may include - Describe the extent of the problem (outbreak); Identify those at risks of dying from heat; Develop interventions to prevent death in future heat waves**

Other possible answers should fall in the following below categories. According to the EXCITE! Website reasons to investigate outbreaks include:

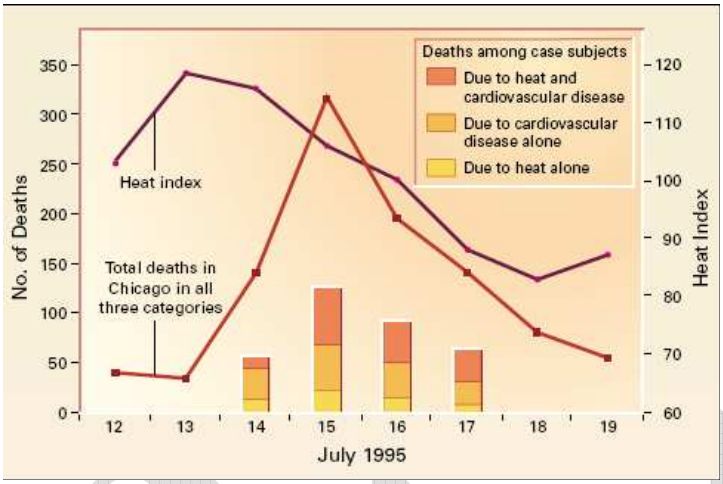
- **Control and prevention**
- **Research opportunities**
- **Training opportunities**
- **Program considerations**
- **Public, political, or legal concerns**

1 Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE, editors. Climate Change 2007: Impacts, Adaptation, and Vulnerability. (Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change). Cambridge (UK): Cambridge University Press; 2007.
2 University of Chicago Press. Dying Alone: An Interview with Eric Klineberg. [online]. 2002 [cited 2008 May 15]. Available from URL http://www.press.uchicago.edu/Misc/Chicago/443213in.html

2. **(2 pts)** Investigations of communicable disease outbreaks typically study people with a particular infection. What was studied in this investigation? - **Risk factors contributing to death during the heat wave**

Disease detectives reviewed death certificates collected by the Department of Public Health in Chicago's Vital Statistics Division. Epidemiologists identified 680 deceased persons with 3 common characteristics related to their deaths. These characteristics included: heat was listed as the immediate or underlying cause of death, with no reference to cardiovascular disease; cardiovascular disease was listed as the primary cause of death, with no reference to heat; and cardiovascular disease was listed as the primary cause, and heat as a contributing cause of death.

Figure 1. Heat Index, Total Deaths, and Deaths of Case Subjects Due to Heat, Cardiovascular Disease, and Heat and Cardiovascular Disease Combined in Chicago, July 12 through July 19, 1995.*



The heat index, or apparent temperature, is a function of the temperature in degrees Fahrenheit and the relative humidity. It provides a measure of the evaporative and radiant transfer of heat between a typical human and the environment. Total numbers of deaths in Chicago with cardiovascular disease or heat as a primary or secondary cause were obtained from the Illinois Department of Public Health. The bars represent case subjects included in the analysis, according to cause of death.

3. **(6 pts)** Write a case definition for this study based on the above information. Case definition: a standard set of criteria for deciding whether, in this investigation, a person should be classified as having the disease or health condition under study. Case definition has 4 components:

   1. clinical information about the disease,
   2. characteristics about the people who are affected,
   3. information about the location or place, and
   4. a specification of time during which the outbreak occurred

   Persons who died in Cook County between July 12 and July 19, 1995 and who had one of the following listed on their death certificate: heat listed as the immediate or underlying cause of death, with no reference to cardiovascular disease; cardiovascular disease listed as the primary cause of death, with no reference to heat; or cardiovascular disease listed as the primary cause and heat as a contributing cause of death. - A complete answer includes each of the highlighted sections.

   2pts: Persons who died in Cook County
   2pts: Between July 12 and July 19, 1995 (must include the year)
   2pts: heat listed as the immediate or underlying cause of death, with no reference to cardiovascular disease; cardiovascular disease listed as the primary cause of death, with no reference to heat; or cardiovascular disease listed as the primary cause and heat as a contributing cause of death

4. **(2 pts**) Why did the disease detectives include persons who died from cardiovascular disease in their study? - **Previous studies had shown that heat waves result in an increase number of deaths due to cardiovascular disease. (Answer found in the introduction)**

5. **(2 pts)** Which of the 3 case groups in Figure 1 showed the greatest increase of deaths during the 4-day heat wave? - **Deaths due to heat and cardiovascular disease**
6. **(4 pts)** How might have publicity and physician awareness of heat waves influenced that increase? **Publicity and physician awareness of the heat wave would make them more likely to include heat as a cause of death on the death certificate.**

Disease detectives took a random sample from each cause-of death category, with stratification according to age, race and date of death. One neighborhood control was selected for each case subject. Controls were matched with the case subjects for age within 5 years, except for case subjects 80 years or older, for whom the range was expanded to 10 years. A uniform questionnaire was used to collect information from interviews with controls and surrogate respondents for the case subjects. Surrogates included family members, friends, or neighbors who were encountered when staff members visited the address on the death certificate. Cases for which no surrogates could be obtained were not included in the analysis.

7. **(2 pts)** What type of study design did disease detectives use for this investigation? - **Case Control Study**
8. **(2 pts)** How did data collection for cases differ from that of controls? - Data about cases was collected from **surrogates** while data from controls was collected **from the individuals themselves**. **The bolded information must be included in a complete answer. 1 pt for concept of "surrogates"/ 1pt for the concept of "data collected by the individuals themselves"**
9. **(2 pts)** How might this influence the validity of the data? - Data from controls is more likely to be **valid** than that from cases. **Answer should include the word "valid" for full credit. 1 pt for "better", "complete", "accurate" etc.**
10. **(2 pts)** What group of identified cases would not be included in the study as described in the case? - **Cases where a surrogate could not be identified.**

Table 1. Number of cases and controls by race and ethnic background.*

TABLE 1. SELECTION AND CHARACTERISTICS OF PERSONS WHO DIED OF HEAT-RELATED OR CARDIOVASCULAR CAUSES IN CHICAGO FROM JULY 14 THROUGH JULY 17, 1995, AND THEIR MATCHED CONTROLS, ACCORDING TO CAUSE OF DEATH.

VARIABLE	CAUSE OF DEATH						TOTAL	
	HEAT		HEAT AND CARDIOVASCULAR DISEASE		CARDIOVASCULAR DISEASE			
	Case Subjects	Controls	Case Subjects	Controls	Case Subjects	Controls	Case Subjects	Controls
	number (percent)							
Category								
Eligible subjects	84	—	353	—	243	—	680	—
Included in sample	80 (95)	—	201 (57)	—	192 (79)	—	473 (70)	—
Interviewed	62 (78)	65	157 (78)	162	153 (80)	151	372 (79)	378
Included in analysis	60	60	144	144	135	135	339	339
Characteristic								
Age (yr)								
<76	37 (62)	43 (72)	83 (58)	100 (69)	63 (47)	87 (64)	183 (54)	230 (68)
≥76	23 (38)	17 (28)	61 (42)	44 (31)	72 (53)	48 (36)	156 (46)	109 (32)
Race*								
Black	24 (40)	28 (47)	69 (48)	72 (51)	58 (43)	59 (44)	151 (45)	159 (47)
White	35 (58)	30 (50)	74 (51)	65 (46)	76 (56)	72 (54)	185 (55)	167 (50)
Other	1 (2)	2 (3)	1 (1)	5 (4)	1 (1)	2 (2)	3 (1)	9 (3)
Hispanic ethnic background	1 (2)	2 (3)	9 (6)	15 (10)	8 (6)	9 (7)	18 (5)	26 (8)
Sex								
Female	27 (45)	32 (53)	66 (46)	73 (51)	67 (50)	76 (56)	160 (47)	181 (53)
Male	33 (55)	28 (47)	78 (54)	71 (49)	68 (50)	59 (44)	179 (53)	158 (47)

*Missing data for the control groups are due to incomplete questionnaires.

11. **(4 pts)** In the space below, calculate the odds ratio for total death between blacks and whites. Use "White" as the exposed variable. Complete the table (including labels) and show all of your work in the space below. -Odds Ratio: the ratio of the odds of being exposed in the group with the outcome to the odds of being exposed in the group without the outcome

	White	**Black**
Cases	**185 (A)**	**151 (B)**
Controls	**167 (C)**	**159 (D)**

Odds Ratio: the ratio of the odds of being exposed in the group with the outcome to the odds of being exposed in the group without the outcome -**OR = (A*D)/(B*C) = (185*159)/(167*151) = 29415/25217 = 1.1664; 1 pt for correct 2x2 table/ 1 pt for correct setup/ 2 pt for correct answer**

12. **(4 pts)** Incidence data presented elsewhere suggested that the relative risk of death among blacks might have been as high as 1.5 times that of whites. How might the study methodology account for this difference? - The investigators picked neighborhood controls and therefore did a certain amount of matching by race as **people of the same race tend to live in the same neighborhoods**. That would have **weakened any possible difference between these two groups.** 2pts for the concept of "people of the same race tend to live in the same neighborhoods" 2pts for the concept of "weakened any possible difference between these two groups. Disease detectives examined the relationships between death and various living and social conditions. They calculated a summary odds ratio for these relationships based on weighted averages of the individual odds ratios for the three causes of death. These are presented in the following table.

Table 5. Living Conditions and Types of Social Contacts Among 339 Matched Pairs of Case Subjects and Controls*

Variable	Case Subjects	Controls	Odds Ratio (95% CI)†
	no. (%)		
Living conditions			
Had working air conditioner in home	81 (25)	170 (53)	0.2 (0.2–0.4)
Had access to air-conditioned lobby	28 (10)	54 (20)	0.2 (0.1–0.5)
Visited cooling shelters	14 (5)	22 (7)	0.5 (0.3–1.2)
Visited other air-conditioned places	67 (22)	130 (43)	0.3 (0.2–0.5)
Lived alone	156 (46)	112 (33)	2.3 (1.4–3.5)
Lived on the top floor‡	83 (52)	51 (32)	4.7 (1.7–12.8)
Type of residence			
Single-family home or duplex§	129 (39)	165 (50)	1.0
Apartment building	185 (57)	155 (47)	2.5 (1.5–4.2)
Other kind of building	13 (4)	7 (2)	8.1 (1.4–45.8)
Number of rooms			
1 or 2	65 (20)	53 (16)	3.4 (1.5–7.9)
3 or 4	87 (27)	72 (22)	2.8 (1.4–5.3)
5 or 6	135 (41)	134 (41)	1.6 (0.9–2.7)
>6§	40 (12)	68 (21)	1.0
Lived in building with flat roof	192 (58)	167 (51)	2.0 (1.2–3.2)
Social contact			
Participated in group activities (clubs, support groups, church)	140 (46)	167 (55)	0.7 (0.5–0.9)
Had access to transportation (car, bus, or train)	262 (79)	303 (92)	0.4 (0.2–0.6)
Had friends in Chicago	288 (90)	312 (97)	0.3 (0.1–0.6)
Did not leave home¶	75 (27)	19 (7)	6.7 (3.0–15.0)
Had pet in home	78 (24)	99 (30)	0.6 (0.4–0.9)

*For each variable, the denominator is based on the number of pairs with no missing data.

†Odds ratios are calculated as the risk of death among subjects with the characteristic in question, as compared with those without it, unless otherwise specified. CI denotes confidence interval.

‡The reference category was subjects who lived below the top floor of an apartment building.

§Reference category.

¶The reference category was those who left home at least once a week.

13. **(4 pts)** Select the three living condition variables which were most protective against death in this study and rank them in increasing order of their apparent protective affect (e.g. least effective goes first)
    - **Visited other air conditioned places**
    - **Had access to air conditioned lobby**
    - **Had working air conditioner in home 1 pt for each answer/ 1 pt for correct order**
14. **(3 pts)** Based on the above results (and assuming you want to live) is it better to live on the top floor or live alone? Explain your answer. **It is better to live alone. (1 pt) The odds ratio for living alone is 2.3 while that for living on the top floor is 4.7. (2 pts)**
15. **(2 pts**) Which of the above social contact variables was most associated with death? **Did not leave home**
16. **(3 pts)** What is the risk of death in residents who lived alone and lived on the top floor? **Not enough information provided in the table to answer**
17. **(5 pts)** What impact did the exclusion of cases that did not have a surrogate have on the magnitude of the estimates of association between variables dealing with social isolation and risk of death? Why? **The associations (odd ratios) are underestimated. (2pts) /The most socially isolated cases were excluded from the study** (because surrogates could not be identified)**. (3 pts)**

Disease detectives hypothesized that persons who had certain underlying medical conditions or who had contact with health care providers might have either an increased or a decreased risk of death. They calculated summary odds ratios for these

relationships based on weighted averages of the individual odds ratios for the three causes of death. These are presented in the following table

Table 6. Medical Conditions and Contacts with Health Care Providers Among 339 Matched Pairs of Case Subjects and Controls*

Variable	Case Subjects	Controls	Odds Ratio (95% CI)†
	no. (%)		
Medical conditions			
Confined to bed	51 (16)	13 (4)	5.5 (2.5–12.1)
Unable to care for self	77 (23)	29 (9)	4.1 (2.0–8.5)
Mental problem	52 (20)	23 (9)	3.5 (1.7–7.3)
Heart condition	92 (39)	46 (19)	2.3 (1.5–3.6)
Pulmonary condition	30 (13)	14 (6)	2.2 (1.0–4.9)
Body-mass index‡			
<24	131 (45)	89 (30)	1.4 (1.0–2.2)
24–27§	81 (28)	82 (28)	1.0
≥28	81 (28)	122 (42)	0.6 (0.4–1.0)
Contact with health care providers			
Visited by nurses	62 (20)	16 (5)	6.2 (2.9–13.4)
Contacted by city workers during heat wave	25 (9)	43 (16)	0.7 (0.3–1.7)
Used housekeeper or home health aide	54 (17)	27 (9)	2.7 (1.5–4.8)
Used Meals on Wheels	22 (7)	12 (4)	2.5 (1.0–6.5)

*For each variable, the denominator is based on the number of pairs with no missing data.

†Odds ratios are calculated as the risk of death among subjects with the characteristic in question, as compared with those without it, unless otherwise specified. CI denotes confidence interval.

‡The weight in kilograms divided by the square of the height in meters.

§Reference category.

18. **(2 pts)** Which of the above medical conditions seemed to put persons at greatest risk of death? **Confined to bed. All other responses are incorrect; multiple answers that include "confined to bed" are also wrong**
19. **(4 pts)** What is the relationship between obesity and death in this study? Explain your answer. **Persons who were obese had a lower risk of death that those who were not obese. (2 pts) The odds ratio for death among people who had a BMI<24 was 1.4 while the odds ratio for those with a BMI>28 was 0.6. (2 pts)**
20. **(4 pts)** Results in Table 5 suggest that contact with others might be protective against heat-related death. Is this supported by data in Table 6? Explain your answer. - **This suggestion is not supported by data in Table 6. (2 pts); Except for contact with city workers, other contacts listed in Table 6 were all associated with an increased odds of death (2 pts)** Investigators then looked at the association between a number of risk factors and risk of death after stratifying by the various causes of death.

Table 7. Selected Factors Associated with the Risk of Heat-Related Death, According to Cause of Death*

Variable	Cause of Death		
	Heat	Heat and Cardiovascular Disease	Cardiovascular Disease
No. of case–control pairs	60	144	135
	odds ratio (95% confidence interval)*		
Heart condition	1.8 (0.6–5.4)	1.5 (0.8–2.8)	4.5 (2.3–8.9)
Mental problem	3.0 (0.8–11.1)	2.6 (1.1–6.2)	5.0 (1.4–17.3)
Confined to bed	2.0 (0.2–22.1)	4.3 (1.4–12.6)	9.0 (2.7–29.7)
Visited by nurses	10.0 (1.2–78.1)	3.8 (1.4–10.2)	8.7 (2.6–28.6)
Unable to care for self	9.0 (1.1–71.0)	1.9 (0.9–4.1)	6.2 (2.9–14.6)
Visited other air-conditioned places	0.1 (0.04–0.5)	0.4 (0.2–0.7)	0.4 (0.2–0.8)
Had working air conditioner	0.2 (0.1–0.6)	0.2 (0.1–0.4)	0.3 (0.2–0.6)
Lived alone	5.7 (1.7–19.3)	2.2 (1.2–3.9)	1.5 (0.9–2.6)
Did not leave home	1.8 (0.5–6.0)	7.3 (2.2–24.5)	7.8 (3.1–19.8)

*Odds ratios are calculated as the risk of death among subjects with the characteristic in question, as compared with those without it.

21. **(3 pts)** For your classmates, translate and write a single statement describing the results in Table 7 for the association between being visited by a nurse and death for persons who had only heat listed as cause of death on their death certificates. - Persons who were **visited by nurses** during the heat wave were **10 times more likely to die from heat** than those **who were not visited by nurses. 1pt for each of the bolded portions**

Disease detectives then used a weighted multivariate analysis to study the association between death during the heat wave and several of the more striking variables after controlling for the affect of other important variables. The results of this analysis are shown in Table 8 below.

Table 8. Association of Risk Factors with Heat-Related Death in the Weighted Multivariate Analysis*

Variable	Case Subjects (N=339)	Controls (N=339)	Odds Ratio (95% CI)*	GIF (%)†
	no. (%)			
Had working air conditioner in home	96 (28)	170 (50)	0.3 (0.2–0.6)	50.2
Visited other air-conditioned places	103 (30)	130 (38)	0.5 (0.3–0.9)	39.5
Had access to transportation	270 (80)	303 (89)	0.3 (0.1–0.5)	16.3
Confined to bed	51 (15)	13 (4)	8.2 (3.1–22.0)	13.7
Lived alone	156 (46)	112 (33)	2.3 (1.2–4.4)	27.1

*Odds ratios are calculated as the risk of death among subjects with the characteristic in question, as compared with those without it. CI denotes confidence interval.

†GIF denotes generalized impact fraction, an estimate of the percentage of deaths attributable to a particular factor or the absence of a particular factor.

They also calculated a generalized impact fraction (GIF) that estimated the percentage of deaths attributable to either the presence of absence of a particular factor.

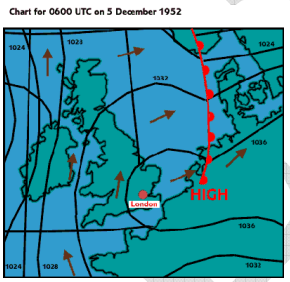
22. **(2 pts)** Based on the information in Table 8, what single device had the greatest impact on attributable deaths? - **Air conditioner**

23. **(6 pts)** Your elderly grandmother lives by herself in Chicago. She has a top floor room above a shoe repair shop. The Weather Channel reports that the heat index in Chicago is 100° and expected to top 120° by midweek. You are talking to her on the phone. Based on the findings of this investigation, list the three most important things she should do to protect herself. **2pts each - Get a roommate; Move from the top floor; Get an air conditioner**

Problem II. Disease Detectives Respond to Air Pollution: Great London Fog 1952Total Suggested time = 20 minutes

Sources: http://www.martinfrost.ws/htmlfiles/smog2.jpg;
http://news.bbc.co.uk/2/shared/spl/hi/pop_ups/02/uk_the_great_smog_of_1952/html/1.stm accessed May 2008

A dense fog covered the Greater London (England) area December 5-8, 1952. There was no pressure gradient during that time and an almost complete absence of wind. This, along with geographical factors, produced a temperature inversion with cold air at ground level overlaid by warmer air. The inversion prevented the dispersal of fog, and also allowed the accumulation of smoke and atmospheric pollution in the Greater London area. The fog finally lifted mid-day on December 9.



Source: http://www.metoffice.gov.uk/education/secondary/students/smog.html

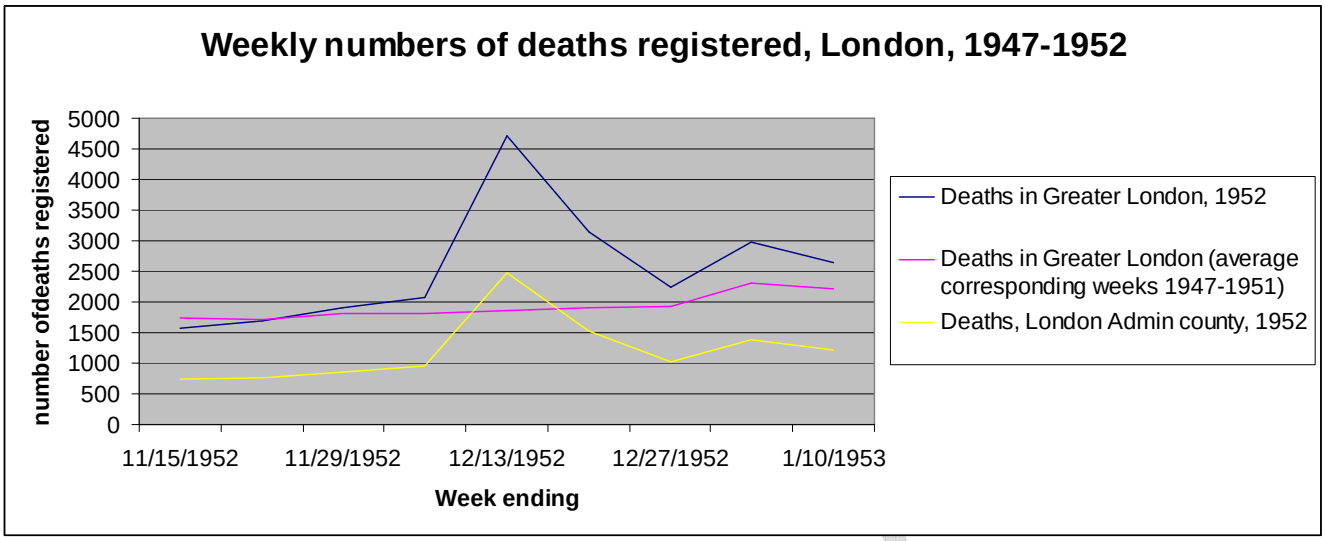
Health officials noted a sudden rise in the number of deaths during and immediately following the period of fog and asked disease detectives to conduct an investigation. Initial reports of the number of deaths showed there were between 3,500 and 4,000 more deaths than would normally have been expected during the first three weeks of December. Disease detectives reviewed death certificates by week from November 15, 1952 to January 10, 1953. Their findings are summarized in the tables below.

Table 1. Number of deaths during the period Nov. 15, 1952 to Jan. 10, 1953, compared with the average of corresponding weeks during the preceding 5 years.*

	Week Ending								
London fog December 1952	**11/15**	**11/22**	**11/29**	**12/6**	**12/13**	**12/20**	**12/27**	**1/3**	**1/10**
Deaths in Greater London, 1952 (Population 8,364,000)	1565	1699	1902	2062	4703	3138	2234	2977	2634
Deaths in Greater London (average corresponding weeks 1947-1951)	(1747)	(1708)	(1809)	(1805)	(1852)	(1914)	(1923)	(2303)	(2213)
Deaths in London Administrative County, 1952 (Population 3,363,000)	747	753	853	945	2484	1523	1029	1372	1216

* Her Majesty's Stationary Office. 1954. Her Majesty's Public Health Service. Mortality and Morbidity during the London Fog of December 1952. Public Health and Medical Subjects Report No. 95.

1. **(6 pts)** In the space below, graph these data. Plot data in the form of a line graph.



1 pt for each correctly labeled axis
1 pt for correct identification of the peak (12/13)
1 pt for each of the 3 lines in correct relative position

2. **(1 pt)** What do disease detectives call this type of line graph?
   Epidemic curve, or epi curv
3. **(2 pts)** What type of epidemic does the shape of the graph indicate for Greater London in 1952?
   Continuing Common Source (2pts)
   Common Source (1pt)
   No credit for point source since scenario describes a wide spread exposure over a several date period.

From each death certificate, the disease detectives recorded demographic information and cause of death.

Table 2. Deaths registered in London by age, December 1952*.

	All Ages	< 4 wks	4 wks-1 yr	1-14 yrs	15-44 yrs	45-64 yrs	65-74 yrs	75 yrs +
Dec 6	945	16	12	10	61	237	254	355
Dec 13	2484	28	26	13	99	652	717	949

* Her Majesty's Stationary Office. 1954. Her Majesty's Public Health Service. Mortality and Morbidity during the London Fog of December 1952. Public Health and Medical Subjects Report No. 95.

4. **(4 pts)** Calculate age-specific, proportionate increase in deaths for the week of December 13th. Write the formula you would use to calculate age-specific proportionate increase and then place your answers in the table below.
   [(Dec 13 count / Dec 6 count) x 100] – 100 = proportionate (or percent) increase
   (2 pts) OR
   (#Deaths week of Dec 13 - #deaths week of Dec 6)/ # Deaths week of Dec 6 (2pts)
   0.25 point for each correct calculation for a total of 2pts

	All Ages	< 4 wks	4 wks-1 yr	1-14 yrs	15-44 yrs	45-64 yrs	65-74 yrs	75 yrs +
	162.86%	**75.00%**	**116.66%**	**30.00%**	**62.30%**	**175.11%**	**182.28%**	**167.32%**

5. **(2 pts)** Explain what your findings mean.
   The age groups most affected are: children 4 weeks to 1 year of age and adults over 45 years (2 pts)
   The age groups most affected are: adults over 45 years (1 pt)
6. **(2 pts)** If you had population data, which age group under 45 years old would you expect to have the highest weekly death rate? **Children under 4 weeks of age (2pts).**
   (While this group has death counts comparable to other age groups, you would expect fewer children in this age group. A smaller denominator for rate calculation would result in a larger weekly death rate.)

Table 3. Number of deaths assigned to various causes, London Admin. County, weeks ending Nov 29, 1952-Jan 3, 1953*

Cause of Death	Week Ended					
	11/29	**12/6**	**12/13**	**12/20**	**12/27**	**1/3**
Vascular lesions of CNS	98	102	128	119	91	131
Heart disease	229	206	525	283	217	286
Influenza	7	2	24	9	6	4
Pneumonia	28	45	168	125	91	104

Bronchitis	73	74	704	396	184	215
Other respiratory diseases	54	68	198	90	70	58
Other causes of death	364	448	737	501	370	574
Total (all causes)	853	945	2484	1523	1029	1372

7. **(8 pts)** Calculate cause-specific mortality rates per 100,000 population for the weeks ending 11/29, 12/13 and 1/3. Write the formula you would use to calculate cause-specific mortality rate and then place your answers in the table below.

(Cause specific weekly count / 3,363,000) x 100,000 = cause specific mortality rate per 100,000 population
2 pts for the formula 0.25 for each answer for a total of 6 pts.

Cause of Death	Week Ended					
	29-Nov		**13-Dec**		**3-Jan**	
Vascular lesions of CNS	98	**2.91**	128	**3.81**	131	**3.89 or 3.90**
Heart disease	229	**6.81**	525	**15.61**	286	**8.5**
Influenza	7	**0.21**	24	**0.71**	4	**0.12**
Pneumonia	28	**0.83**	168	**4.99 or 5.00**	104	**3.09**
Bronchitis	73	**2.17**	704	**20.93**	215	**6.39**
Other respiratory diseases	54	**1.61**	198	**5.89**	58	**1.72**
Other causes of death	364	**10.82**	737	**21.91**	574	**17.07**
Total (all causes)	853	**25.36**	2484	**73.86**	1372	**40.79 or 40.80**

* Her Majesty's Stationary Office. 1954. Her Majesty's Public Health Service. Mortality and Morbidity during the London Fog of December 1952. Public Health and Medical Subjects Report No. 95.

8. **(3 pts)** List the leading cause of death for each of the three weeks excluding "other causes of death".
   11/29 heart disease
   12/3 bronchitis
   1/3 heart disease

Medical officers in various London boroughs were asked to look for evidence of infectious diseases, particularly upper respiratory diseases, which might account for the sudden rise in deaths. Because their reports did not follow a standardized form, the data they collected could not be tabulated for analysis. However, in general, no evidence of infectious agents was obtained, and with relatively few exceptions, illness was confined to one member of a household.

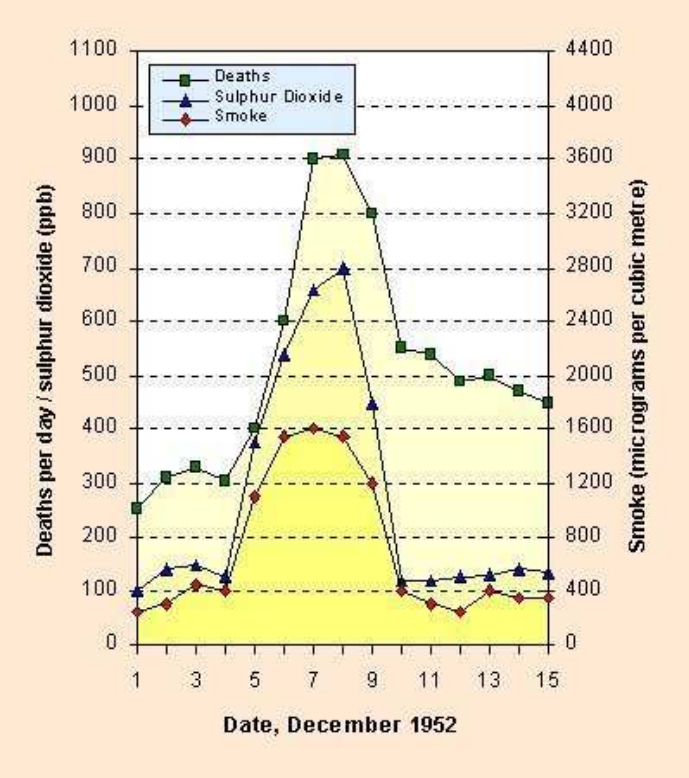
9. **(2 pts)** What information from the **mortality records** presented to you earlier supports the findings of the borough medical officers?
   The mortality rate for influenza had only a small increase for week ending 12/13 in comparison to the large increase in mortality rate for bronchitis.

Atmospheric pollution was measured routinely throughout England. Daily estimations were made of total suspended matter, or TSM, measured in micrograms per cubic meter, ($\mu gm/m^3$) and of sulfur dioxide, measured in parts per billion (ppb). Daily readings for the 12 monitoring sites located in the Greater London area were provided by local authorities. Disease detectives calculated an average daily reading and compiled these data with daily death counts for the first two weeks of December 1952.

Table 4. Daily measurements of sulfur dioxide (ppb), total suspended matter ($\mu gm/m^3$), and deaths, Greater London, December 1952*

	December 1952														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Sulfur Dioxide, ppb	100	125	130	110	375	525	670	700	440	100	110	120	130	140	130
TSM, $\mu gm/m^3$	300	350	425	400	1100	1575	1600	1575	1200	400	350	200	400	375	375
Death Count	200	300	310	295	390	590	900	910	800	550	540	490	510	475	450

* Her Majesty's Stationary Office. 1954. Her Majesty's Public Health Service. Mortality and Morbidity during the London Fog of December 1952. Public Health and Medical Subjects Report No. 95.



Source: http://www.metoffice.gov.uk/education/secondary/students/smog.html

10. **(4 pts)** List 4 criteria disease detectives use for determining causality when conducting investigations.
    1 pt for each up to 4 total
    Strength of association
    Consistency of observed association
    Specificity of association
    Temporal sequence of events
    Dose-response relationship or gradient
    Biological plausibility of the observed association
    Experimental evidence
    Also accept
        Coherence
        analogy
11. **(3 pts)** Can you identify the cause of this epidemic from this information? Why, or why not?
    No. (1 pt) The data presented are an ecologic comparison (1pt) and have no individual exposure information. (1pt) - Must have both for complete credit (2pts)

In early 2000, researchers in the United States re-evaluated the data for deaths and air pollution monitoring more closely to see what relationships might exist. They used a statistical method called regression analysis to see how daily minimum and maximum temperature, relative humidity, and the previous day's concentrations of smoke or particles (TSM) and of sulfur dioxide (SO_2) were related to daily mortality. Their findings are summarized in the following table.

Table 5. Relative Risk for Daily Mortality and the Previous Day's Pollution Levels*

	Greater London	London Administrative County
SO_2 (0.10-ppm increase)	1.19 (1.12–1.27)	1.24 (1.14–1.35)
Adjusted for maximum temperature	1.27 (1.17–1.38)	1.34 (1.20–1.51)
TSM (100-µg/m3 increase)	1.08 (1.05–1.10)	1.10 (1.06–1.13)
Adjusted for maximum temperature	1.08 (1.06–1.10)	1.09 (1.07–1.12)

* Bell ML, Davis DL. Reassessment of the Lethal London Fog of 1952: Novel Indicators of Acute and Chronic Exposure to Air Pollution. Environ Health Perspect. 109(Suppl 3):389-394 (2001).

12. **(6 pts)** You are describing this study to your Science Olympiad teammates. In one sentence tell your team the most

important finding or findings in this table.

In Greater London, the relative risk for death, adjusted for maximum temperature (1pt) was 1.27 (1pt) for each 0.10 ppm (1pt) increase in SO_2 (1pt) concentration. and

In London Administrative County, the relative risk for death, adjusted for maximum temperature (1pt) was 1.34 (1 pt) for each 0.10 ppm (1 pt) increase in SO_2 (1pt) concentration.

6 points total if both answers given correctly

"Legislation followed the Great Smog of 1952 in the form of the City of London (Various Powers) Act of 1954 and the Clean Air Acts of 1956 and 1968. These Acts banned emissions of black smoke and decreed that residents of urban areas and operators of factories must convert to smokeless fuels. As these residents and operators were necessarily given time to convert, however, fogs continued to be smoky for some time after the Act of 1956 was passed. In 1962, for example, 750 Londoners died as a result of a fog, but nothing on the scale of the 1952 Great Smog has ever occurred again."[3]

* Semenza, JC, Rubin CH, Falter KH, Selanikio JD, Flanders WD, Howe HL, Wilhelm JL Heat-Related Deaths During the July 1995 Heat Wave in Chicago. N Engl J Med 1996;(335)84-90.

3 Met Office. The Great Fog 1952. [online]. 2008 [cited 2008 May 20]. Available from URL http://www.metoffice.gov.uk/education/secondary/students/smog.html.