Original Article

Analysis of Causes of Death in Nakhon Sawan Province, with Emphasis on Infectious Diseases

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Abstract

Infectious disease was the second common cause of death in Nakhon Sawan Province. It was the important leading cause of mortality, representing 14.2 percent of total causes of death or 51.6 per 100,000 population. Most of the infectious diseases were not preventable by vaccines. HIV/AIDS was the most common infectious diseases, counting for 361 out of 596 (60.6%). The most common HIV affected age group was 25-44 years and males were significantly affected more than female ($p < 0.05$), followed by age group of 15-24 and 45-59 years (11 females in each group; 24 and 26 males respectively). When compared by age group, the deceased persons in age group < 1 year were affected by infectious disease (50% of total mortality in this age group in both genders) more than others, and were due to dengue infection and pneumonia. Deceased persons in 25-44 years (36.5% in females and 38.1% in males) were affected mostly by HIV/AIDS. Wasting syndrome was the most common HIV-related disease in both genders (38.0 and 39.8% in females and males respectively). Health education especially in mothers, good health care and sanitation, early seeking for health care, and early diagnosis with prompt and proper treatment should decrease the infectious mortality in children. In adults, intensive interventions to prevent HIV and related diseases are the most important strategy, including consistent condom use, reduce alcoholic drinking, avoid drug abuse, safe sexual behavior, chemotherapy to prevent opportunistic infections and to prevent HIV transmission from mother to child. *(J Infect Dis Antimicrob Agents 2001;18:1-7.)*

INTRODUCTION

Infectious disease remains the leading cause of death worldwide, especially in developing countries.[1] Most infections are re-emerging and emerging diseases.[2] Tuberculosis is the leading cause of death among infectious diseases.[3,4] Co-infection with human immunodeficiency virus (HIV) greatly enhances the risk of overt tuberculosis, and it is expected that tuberculosis will account for 30 percent of HIV-related death in 1999.[3]

Medically certified information is available for less than 10 percent[5]; and is mostly the mode of death, not the cause of death, and is told by the deceased relatives which may not be correct. Reliable information on causes of death is essential to the development of provincial and national health policies for prevention and control of diseases and injuries. Epidemiological data about causes of death in Nakhon Sawan Province, and even in Thailand and Southeast Asian Countries are not well established.[6] Thus this study was done by Nakhon Sawan Provincial Health Office in collaboration with the

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Bureau of Health Policy and Planning, Ministry of Public Health (MOPH), to identify specific causes of death of people in Nakhon Sawan Province. The aim of this study is to establish the specific causes of death in Nakhon Sawan Province, with emphasis on infectious diseases. This may help develop the policy in prevention and control of these diseases in target groups at risk.

MATERIALS AND METHODS

All persons in Nakhon Sawan Province who died during July 1, 1997 and June 30, 1998 were included in the study. Thirty-three nurses and 183 personal officers of Health Centers, District Health Offices, Community and Regional Hospitals in Nakhon Sawan Province were trained for using a verbal autopsy questionnaire and a handbook guideline[7], which were prepared by the Bureau of Health Policy and Planning, MOPH. Field interview of the deceased relatives and other knowledgeable persons were done at their homes. Conferences of the interviewed cases with available local hospital records were conducted between interviewers and the representative hospital physicians to make the provisional diagnosis of causes of death. After that the questionnaires were sent to the Nakhon Sawan Provincial Health Office. Data from questionnaires and other available health records from Maternal and Child Health, the Jiraprawat (Army), 5 private, 12 community and regional hospitals were reviewed by a physician expert in Internal Medicine of the Nakhon Sawan Provincial Health Office to determine the specific causes of death of each deceased person using the tenth Revision International Classification of Diseases. Of the 4,490 questionnaires obtained, only 4,187 of them were appropriate for analysis. The deceased persons were categorized into 8 age groups: < 1, 1-4, 5-14, 15-24, 25-44, 45-59, 60-74 and > 75 years. Statistic Package for Social Science (SPSS) for window program was used for data processing.

RESULTS

Ten leading causes of death were shown in Table 1. Infectious disease was the second most common cause, representing 14.2 percent of all total causes of death or 51.6 per 100,000 population. Circulatory system disease was the most common, whereas malignant neoplasm, senility, traffic accidents, diabetes mellitus, chronic lower respiratory disease, liver disease, suicide and homicide were the 3-10 leading causes of death respectively.

HIV/AIDS was the most common infectious disease (60.6%), whereas tuberculosis (not related to HIV/AIDS) was the second most common (10.7%). The other causes of death in order of frequency included pneumonia, intestinal infection, dengue hemorrhagic fever (DHF), bacterial infection of central nervous system (CNS), septicemia, cholecystitis with/without gall stones, malaria, viral infection of CNS, skin and subcutaneous infection, peritonitis, viral hepatitis and tetanus (Table 2).

According to death certificates, there were only 15 cases of HIV/AIDS, which were less than this study (361 cases) whereas the Provincial Communicable Disease Report revealed only 108 cases of HIV death. Mortality due to HIV/AIDS in males (269

Table 1. Ten leading causes of death in Nakhon Sawan Province (n = 4,187).

Rank	Diseases	Number	% of total causes of death	Rate/ 100,000 population
1	Circulatory system disease	1,023	24.4	88.6
2	Infectious disease	596	14.2	51.6
3	Malignant neoplasm	519	12.4	45.0
4	Senility	481	11.5	41.7
5	Traffic accident	321	7.7	27.8
6	Diabetes mellitus	201	4.8	17.4
7	Chronic lower respiratory disease	189	4.5	16.4
8	Liver disease	149	3.6	12.9
9	Suicide	112	2.7	9.7
10	Homicide	65	1.6	5.6

Note: Total Nakhon Sawan population = 1,154,000

cases) was about 3 times more than females (92 cases). Most of the deceased persons in both genders were in the age groups of 25-44 years (63 cases in females and 209 cases in males; $p < 0.05$). HIV/AIDS in children were seen only 0, 2, 1 cases in females, and 1, 3, 3 cases in males in age groups of <1, 1-4 and 5-14 years respectively, and represented 0, 13.3, 4.0 percent in females, and 5.6, 9.7, 11.1 percent in males respectively (Table 3, 4). Details of HIV disease and concomitant diseases with specified gender and age groups were shown in Table 5-6.

Table 2. Causes of death due to infectious diseases.

Diseases	Number (%)
HIV/AIDS	361 (60.6)
Tuberculosis	64 (10.7)
Pneumonia	45 (7.6)
Intestinal infection	38 (6.4)
Dengue hemorrhagic fever	15 (2.5)
Bacterial infection of CNS	14 (2.4)
Septicemia	10 (1.7)
Cholecystitis	7 (1.2)
Malaria	6 (1.0)
Viral infection of CNS (excluding rabies)	5 (0.8)
Skin and subcutaneous infection	5 (0.8)
Peritonitis	4 (0.7)
Viral hepatitis	3 (0.5)
Tetanus	2 (0.3)
Others	21 (2.8)
Total	596 (100.0)

Note: CNS = central nervous system.

DISCUSSION

The mortality due to infectious diseases in Nakhon Sawan Province was high and similar to the previous reports from less developed countries.[8-9] HIV/AIDS was the most common infectious disease. According to death certificates and the Provincial Communicable Disease Report, the figure was much less than our study. Thus it should be remarked that similar to a previous study[10], HIV/AIDS mortality in our study was underreported. HIV-related diseases may cause reversal in mortality of the population and health care of the nation.[11-12] The mortality due to HIV/AIDS was more common in males and were

Table 3. Causes of death due to infectious diseases in females, classified by age group.

Diseases	Number (%) of deceased females, classified by age group (year)								
	<1 (n = 8)	1-4 (n = 15)	5-14 (n = 25)	15-24 (n = 46)	25-44 (n = 197)	45-59 (n = 266)	60-74 (n = 495)	> 75 (n = 772)	Total (n = 1,832)
HIV/AIDS	0	2 (13.3)	1 (4.0)	11 (23.9)	63 (32.0)	11 (4.1)	4 (0.8)	0	92 (5.0)
Tuberculosis	0	0	0	0	1 (0.5)	1 (0.4)	11 (2.2)	14 (1.8)	27 (1.5)
Pneumonia	1 (12.5)	0	0	1 (2.2)	1 (0.5)	1 (0.4)	4 (0.8)	14 (1.8)	22 (1.2)
Intestinal infection	1 (12.5)	1 (6.7)	0	1 (2.2)	0	1 (0.4)	6 (1.2)	11 (1.4)	21 (1.1)
Dengue hemorrhagic fever	2 (25.0)	1 (6.7)	4 (16.0)	0	0	0	0	0	7 (0.4)
Bacterial infection of CNS	0	0	1 (4.0)	0	1 (0.5)	1 (0.4)	1 (0.2)	0	4 (0.2)
Septicemia	0	0	0	0	0	1 (0.4)	2 (0.4)	4 (0.5)	7 (0.4)
Cholecystitis	0	0	0	0	0	0	3 (0.6)	2 (0.3)	5 (0.3)
Malaria	0	0	0	0	1 (0.5)	1 (0.4)	0	0	2 (0.1)
Viral infection of CNS (excluding rabies)	0	0	0	1 (2.2)	3 (1.5)	0	0	0	4 (0.2)
Skin and subcutaneous infection	0	0	0	0	0	0	0	3 (0.4)	3 (0.2)
Peritonitis	0	0	0	0	0	0	1 (0.2)	1 (0.1)	2 (0.1)
Viral hepatitis	0	0	0	0	0	0	1 (0.2)	0	1 (0.1)
Tetanus	0	0	0	0	0	0	1 (0.2)	1 (0.1)	2 (0.1)
Others	0	0	0	0	2 (1.0)	1 (0.4)	3 (0.6)	1 (0.1)	7 (0.4)
Total	4 (50.0)	4 (26.7)	6 (24.0)	14 (30.5)	73 (36.5)	17 (6.9)	37 (7.4)	51 (6.5)	206 (11.3)

Note: CNS = central nervous system.

Table 4. Causes of death due to infectious diseases in males, classified by age group.

Diseases	Number (%) of deceased males, classified by age group (year)								
	< 1 (n = 18)	1-4 (n = 31)	5-14 (n = 27)	15-24 (n = 136)	25-44 (n = 586)	45-59 (n = 390)	60-74 (n = 604)	> 75 (n = 557)	Total (n = 2,355)
HIV/AIDS	1 (5.6)	3 (9.7)	3 (11.1)	24 (17.6)	209 (35.7)	26 (6.7)	3 (0.5)	0	269 (11.4)
Tuberculosis	0	0	0	0	1 (0.2)	7 (1.8)	16 (2.6)	13 (2.3)	37 (1.6)
Pneumonia	4 (22.2)	2 (6.4)	1 (3.7)	0	1 (0.2)	0	3 (0.5)	12 (2.2)	23 (1.0)
Intestinal infection	1 (5.6)	3 (9.7)	1 (3.7)	0	3 (0.5)	2 (0.5)	5 (0.8)	2 (0.4)	17 (0.7)
Dengue hemorrhagic fever	0	3 (9.7)	4 (14.8)	0	1 (0.2)	0	0	0	8 (0.3)
Bacterial infection of CNS	2 (11.1)	0	0	2 (1.5)	3 (0.5)	0	1 (0.2)	2 (0.4)	10 (0.4)
Septicemia	1 (5.6)	0	0	0	0	0	1 (0.2)	1 (0.2)	3 (0.1)
Cholecystitis	0	0	0	0	0	1 (0.2)	0	1 (0.2)	2 (0.1)
Malaria	0	0	0	0	4 (0.7)	0	0	0	4 (0.2)
Viral infection of CNS (excluding rabies)	0	1 (3.2)	0	0	0	0	0	0	1 (0.04)
Skin and subcutaneous infection	0	0	0	0	0	0	1 (0.2)	1 (0.2)	2 (0.1)
Peritonitis	0	0	0	0	0	0	1 (0.2)	1 (0.2)	2 (0.1)
Viral hepatitis	0	0	0	0	0	2 (0.5)	0	0	2 (0.1)
Tetanus	0	0	0	0	0	0	0	0	0
Others	0	0	0	1 (0.7)	1 (0.2)	4 (1.0)	1 (0.2)	1 (0.5)	10 (0.4)
Total	9 (50.0)	12 (38.7)	9 (33.3)	27 (19.8)	233 (38.1)	42 (10.7)	32 (5.4)	36 (6.5)	390 (16.6)

Note: CNS = central nervous system.

Table 5. Details of HIV disease and concomitant diseases in females, classified by age group.

Diseases	Number (%) of specified age group							
	< 1	1-4	5-14	15-24	25-44	45-59	60-74	Total (%)
HIV disease resulting in tuberculosis	0	0	0	1	3	2	0	6 (6.5)
HIV disease resulting in other mycoses*	0	0	0	2	4	0	1	7 (7.6)
HIV disease resulting in PCP	0	1	0	1	4	1	0	7 (7.6)
HIV disease resulting in multiple infections	0	0	0	1	4	0	0	5 (5.4)
HIV disease resulting in other types of NHL**	0	0	0	0	1	0	0	1 (1.1)
HIV disease resulting in wasting syndrome	0	0	1	4	24	5	1	35 (38.0)
HIV disease resulting in multiple diseases	0	1	0	2	19	2	1	25 (27.2)
Unspecified HIV disease	0	0	0	0	4	1	1	6 (6.5)
Total number (%)	0	2 (2.1)	1 (1.1)	11 (12.0)	63 (68.5)	11 (12.0)	4 (4.3)	92 (100.0)

Note: PCP = *Pneumocystis carinii* pneumonia, NHL = non-Hodgkin's lymphoma, * exclude candida infection, ** exclude Burkitt's lymphoma and Kaposi's sarcoma.

common in the age group of 25-44 years. Pediatric HIV/AIDS was less commonly found in our study even though the United Nations Program on HIV/AIDS (UNAIDS) estimated that 1,500 children under 15 years of age were infected every day[13], and the figure was less than those in the upper northern provinces.

Most HIV-related diseases in both genders were wasting syndrome and multiple diseases, which were commonly found in the age group of 25-44 years. *Pneumocystis carinii* pneumonia (PCP) were found in 7.6 percent of females and 8.9 percent of males,

Table 6. Details of HIV disease and concomitant diseases in males, classified by age groups.

Diseases	Number (%) of specified age group							
	<1	1-4	5-14	15-24	25-44	45-59	60-74	Total (%)
HIV disease resulting in tuberculosis	0	0	0	1	8	1	1	11 (4.1)
HIV disease resulting in other mycoses*	0	1	1	7	25	1	1	36 (13.4)
HIV disease resulting in PCP	1	0	0	0	20	3	0	24 (8.9)
HIV disease resulting in multiple infections	0	0	1	0	6	1	0	8 (3.0)
HIV disease resulting in unspecified infections	0	0	0	0	1	0	0	1 (0.4)
HIV disease resulting in encephalopathy	0	0	0	0	1	1	0	2 (0.7)
HIV disease resulting in wasting syndrome	0	0	1	9	87	9	1	107 (39.8)
HIV disease resulting in multiple diseases	0	1	0	7	56	9	0	73 (27.1)
Unspecified HIV disease	0	1	0	0	5	1	0	7 (2.6)
Total number (%)	1 (0.4)	3 (1.1)	3 (1.1)	24 (8.9)	209 (77.7)	26 (9.7)	3 (1.1)	269 (100.0)

Note: PCP = *Pneumocystis carnii* pneumonia, * exclude candida infection.

whereas tuberculosis were found in 6.5 percent of females and 4.1 percent of males. Most of tuberculosis in HIV-infected persons were pulmonary, few cases were tuberculous lymphadenitis. It was seen that mortality of tuberculosis in HIV positive patients are more than HIV negative patients[14], but HIV positive individuals can transmit the bacteria to their close contacts less than HIV negative individuals.[15] Most of fungal infections were cryptococcal meningitis. Non-Hodgkin's lymphoma and encephalopathy were uncommonly seen. Intensive intervention to prevent HIV and related diseases should include consistent condom use, reduce alcoholic drinking, avoid drug abuse, safe sexual behavior, chemotherapy to prevent PCP, tuberculosis and mycoses infections, and antiretroviral drug usage in the mothers. These interventions can reduce risk of sexual[16] and maternal transmission[17] of HIV around 50 percent each.

Tuberculosis (TB) in non HIV patients was the second common infectious disease. Most of them were pulmonary TB, and the others were 2 cases of TB meningitis, one case of TB lympadenitis, and one case TB bone and joint. Globally, tuberculosis is the leading cause of death associated with infectious diseases[18], and it was expected to increase because of the interaction with HIV/AIDS epidemics. Directly observed treatment short-course chemotherapy (DOTS) may improve the treatment outcome. Pneumonia, the third leading cause of death from infectious disease, was mostly seen in elderly and was the cause of morbidity and health care problems.[19] Most of the organisms causing pneumonia were not identified. However, laboratory study including chest radiograph, sputum gram stain and culture have their limited value on diagnosis of community-acquired pneumonia.[20] In children, pneumonia was found more significantly in males and was the significant cause of death, especially in neonates. In the United States, it was also found that low birth weight, prematurity, and male gender were associated with post-neonatal mortality due to non-congenital infection.[21]

Intestinal infection was found mostly in the elderly and children under 5 years of age. This infection was the disease in developing countries where poor sanitary and hygiene exist.[22-23] DHF was found mostly in children aged 5-14 years. In 1997, there were 1,574 cases of dengue fever/ DHF infections in Nakhon Sawan Province. Total mortality of 15 cases or 0.95 percent or 1.29 per 100,000 population were more than the target of the MOPH policy which should be less than 0.2 percent, but concurred with the study of Koxik et al[24] (1.4 : 100,000 population) in Kamphaeng Phet Province, the nearby of Nakhon Sawan Province. Control of the adult and larvae of the mosquito vector by physical, biological, and chemical agents will reduce the DHF infections. Early diagnosis with prompt and proper treatment could reduce the mortality from DHF infection. Bacterial infection of CNS in females were found mostly in adults, but in males, it was also found in neonates and elderly. Viral infection of CNS in females were found in young adults, but in males, it was found in young children. A study from Afghanistan[22] found that CNS infections were associated with high mortality,

especially among the neonates. Septicemia was found in females twice as much as in males. Cholecystitis with or without gall stones were commonly found in female adults and elderly, probably because they were fatty than males. The mortality due to malaria was not commonly found because Nakhon Sawan Province is not the endemic area of malaria. Tetanus neonatorum, the index of poor health care and education was not found in this study. In Italy[25], tetanus mortality was found in elderly persons who were affected ten times more common than younger individuals.

The mortality from infectious diseases were found most commonly in neonates and adults aged 25-44 years, who were mostly infected by HIV. Most infectious diseases found in our study are not preventable by vaccines. Health education especially in mothers, good health care and sanitation, early seeking for health care, and early diagnosis with prompt and proper treatment should decrease the childhood mortality due to infectious diseases. In adults which were affected by HIV/AIDS, intensive interventions to prevent HIV and related diseases are the most important to do. These include consistent condom use, reduce alcoholic drinking, avoid drug abuse, safe sexual behavior, chemotherapy to prevent opportunistic infections, and antiretroviral drugs in pregnant women. Appropriate interventions can reduce risk of sexual and maternal transmission of HIV.[16,17]

In conclusion, infectious diseases were still the important leading cause of death in Nakhon Sawan Province. Most of them were not vaccine preventable, and affected children more commonly, except in HIV/AIDS. HIV/AIDS was the most common infectious disease and was found mostly in adults aged 25-44 years. Verbal autopsy is an effective tool in verifying mortality outside the hospital. Validity of verbal autopsy questionnaire and handbook guideline, well-trained interviewers, and good quality of hospital records should result in corrected cause-specific mortality data. It should remark in mind that previous infectious mortality data were under-reported especially mortality due to HIV/AIDS.

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References

1. Hinman AR. Global progress in infectious disease control. Vaccine 1998;16:1116-21.
2. World Health Report 1996 (WHO, Geneva). J Commun Dis 1996;28:215-9.
3. Zumia A, Squire SB, Chintu C, Grange JM. The tuberculosis pandemic: implications for health in the tropics. Trans R Soc Trop Med Hyg 1999;93:113-7.
4. Hirohata T. Epidemiological studies in Japan. J Epidemiol 1996;6 (Suppl. 3):S13-7.
5. Murray CJ, Lopez AD. Mortality by cause for eight regions of the world: Global Burden of Disease Study. Lancet 1997;349:1269-76.
6. Measurement of overall and cause-specific mortality on infants and children: Memorandum from a WHO/UNICEF Meeting. Bull World Health Organ 1994;72:707-13.
7. Porapakgham Y. Handbook guideline for verbal autopsy. Study causes of death in Thailand, February 1, 1999. The Bureau of Health Policy and Planning, MOPH.
8. Taylor R, Lewis ND, Levy S. Societies in transition: mortality patterns in Pacific Island populations. Int J Epidemiol 1989;18:634-46.
9. Michalek AM, Mahoney MC, Cummings KM, et al. Mortality patterns among a Native American in New York State. NY State J Med 1989;89:557-61.
10. Chang HGN, Morse DL, Noonan C, et al. Survival and mortality patterns of an acquired immunodeficiency syndrome (AIDS) cohort in New York State. Am J Epidemiol 1993;138:341-9.
11. Tollman SM, Kahn K, Garenne M, Gear JS. Reversal in mortality trends: evidence from the Agincourt field site, South Africa, 1992-1995. AIDS 1999;13:1091-7.
12. Todd J, Balira R, Grosskurth H, et al. HIV-associated adult mortality in a rural Tanzanian population. AIDS 1997;11: 801-7.
13. Joint United Nations Programme on HIV/ AIDS (UNAIDS), 1999. World AIDS Campaign: facts and figures. Geneva UNAIDS, 1999.
14. Van den Broek J, Mfinanga S, Moshiro C, et al. Impact of human immunodeficiency virus on the outcome of treatment and survival of tuberculosis patients in Mwanza, Tanzania. Int J Tuberc Lung Dis 1998;2:547-52.
15. Espinal MA, Perez EN, Baez J, et al. Infectiousness of *Mycobacterium tuberculosis* in HIV-1-infected patients with tuberculosis: a prospective study. Lancet 2000;355:275-80.
16. Celentano DD, Bond KC, Lyles CM, et al. Preventive intervention to reduce sexual transmitted infections. Arch

Intern Med 2000;160:535-40.
17. Shaffer N, Chuachoowong R, Mott PA, et al. Short-course zidovudine for perinatal HIV-1 transmission in Bangkok, Thailand: a randomized controlled trial. Lancet 1999;353: 773-80.
18. Estimates of future global tuberculosis morbidity and mortality. Morb Mortal Wkly Rep 1993;42:961-4.
19. Ely EW, Haponik EF. Pneumonia in the elderly. J Thorac Imaging 1991;6:45-61.
20. Bowton DL, Bass DA. Community-acquired pneumonia: the clinical dilemma. J Thorac Imaging 1991;6:1-5.
21. Read JS, Troendle JF, Klebanoff MA. Infectious disease mortality among infants in the United States, 1983 through 1987. Am J Public Health 1997;87:192-8.
22. Choudhry VP, Fazal I, Aram G, et al. Pattern of preventable diseases in Afghanistan: suggestions to reduce the morbidity and mortality at IGICH. Indian Pediatr 1989;26:654-9.
23. Huang W, Yu H, Wang F, Li G. Infant mortality among various nationalities in the middle part of Guizhou, China. Soc Sci Med 1997;45:1031-40.
24. Kozik CA, Suntayakorn S, Vaughn DW, et al. Causes of death and unintentional injury among school children in Thailand. Southeast Asian J Trop Med Public Health 1999;30:129-35.
25. Prospero E, Appignanesi R, D'Errico MM, Carie F. Epidemiology of tetanus in the Marches Region of Italy, 1992-95. Bull World Health Organ 1998;76:47-54.