Journal of Infectious Diseases & Preventive Medicine

Mungrue, J Infect Dis Preve Med 2017, 5:1
DOI: 10.4172/2329-8731.1000153

Research Article Open Access

The Lingering Occurrence of Leprosy in Trinidad in To the 21st Century

Mungrue K*

Faculty of Medical Sciences, St Augustine, University of the West Indies, Trinidad

Abstract

Objective: The aim of this study is to track the occurrence of Hansen's disease (HD) to define the attainment of the goal of elimination, and to describe the ongoing epidemiological features of leprosy in the first decade of the 21st century.

Design and Methods: The data for the study was derived from the National Hansen's Disease Registry of the Ministry of Health for the period 1972-2015. The annual cumulative incidence rate (CIR) per 10 000 populations as well as prevalence was used to measure the occurrence of HD for the period 1972-2015. In order to test a statistically significant trend Poisson regression was used. The Mann-Kendall test was used to determine the significance of trends, a p-value of <0.05 was considered significant.

Results: A peak CIR occurred in 1973 i.e.1.3 per 10 000 population (95% CI 1.5-1.1). Subsequently from 1974 the CIR for HD in Trinidad declined steadily, realizing a decline of 86%. There were no major outliers except for two small peaks 1994 and 2001; hence no smoothing techniques or transformations were necessary. The Mann-Kendall test was highly significant for trends (p=0.01). In addition the prevalence rate also fell to <1 per 10 000 population.

Conclusions: Consequently Trinidad and Tobago has met the WHO criterion for the elimination of HD i.e. <1 case per 10 000 population since 1974.

Keywords: Hansen's disease; Chronic infectious disease; *Mycobacterium lepromatosis;* World Health Organization; Chemotherapy

Introduction

Leprosy continues to occur in Trinidad a small island state seven miles east of Venezuela. Leprosy probably the oldest human-specific infection is a chronic infectious disease of the skin and nerves caused by ***Mycobacterium leprae*** and the newly discovered ***Mycobacterium lepromatosis*** [1]. From the parable of Lazarus (Luke 16:20 King James version), to Shakespeare's Hamlet (Act 1, scene 5) both the medical and nonmedical literature is replete with references to Leprosy [2]. The Norwegian physician Gerhard Armauer Hansen identified the bacillus in 1873. This discovery dispelled the notion held for centuries that it was an inherited disease, thus making leprosy the first disease ascribed to a bacterial origin and for which the disease was also named Hansen's disease (HD). The leprosy bacilli dwell strictly in the intracellular milieu of macrophages and nerve Schwann cells. Once out of the human body they fail to grow on artificial media, unlike all other ***Mycobacterium*** species. Although two exit routes of ***M. leprae*** from the human body i.e. the skin and the nasal mucosa has been described the nasal mucosa appears to be the predominant exit. The quantity of bacilli from nasal mucosal lesions in lepromatous leprosy ranges from 10,000 to 10,000,000 [3]. The majority of lepromatous patients show leprosy bacilli in their nasal secretions as collected through blowing the nose [4]. Nasal secretions from lepromatous patients could yield as much as 10 million viable organisms per day [5]. The entry route of M. leprae into the human body is also not definitively known. The skin and the upper respiratory tract are most likely; however, recent research increasingly favors the respiratory route [6,7]. The normal incubation period ranges from 3 to 7 years [8]. The disease manifests first in discoloration of the skin and then in rashes and nodules and can be progressive and cause permanent damage if left without treatment. The introduction of dapsone (diphenyl sulfone, DDS) in 1941 brought the first effective therapy, followed by multidrug therapy (MDT) introduced by the World Health Organization (WHO) in 1981, to limit the development of drug resistance.

The registered prevalence globally at the beginning of 2012 was 181 941 cases [8]. At the beginning of 2014, there were 215 656 reported cases, suggesting a pause in the elimination of leprosy [9]. This is against a background in which the enhanced global strategy for further reducing the disease burden of leprosy 2011–2015 is being implemented by national programs in endemic countries [10]. The strategy aims to reduce the global rate of new cases with grade-2 disabilities per 100 000 population by at least 35% by the end of 2015. WHO has defined "elimination" as a prevalence rate of less than 1 case per 10,000 inhabitants, a target WHO hopes to achieve if all patients are detected and cured by using multidrug therapy (MDT).

The aim of this study is to track the occurrence of leprosy to define the attainment of the goal of elimination, and to describe the ongoing epidemiological features of leprosy in the first decade of the 21st century.

Methods

The data for the study was derived from the National Hansen's Disease Registry of the Ministry of Health (MoH) for the period 1972-2015. HD treatment and control is a vertical program in the MoH, dedicated to all aspects of the disease including diagnosis, treatment, follow up and support services, and represents the most reliable source of data. Leprosy was defined clinically as someone who: 1) has a skin patch or patches with a definite loss of sensation, confirmation of the disease by biopsy; and 2) has not completed a full course of MDT treatment. Although WHO has simplified the

***Corresponding author:** Mungrue K, Faculty of Medical Sciences, St Augustine, University of the West Indies, Trinidad; E-mail: kameel.mungrue@sta.uwi.edu

Received December 11, 2016; **Accepted** February 16, 2017; **Published** February 23, 2017

Citation: Mungrue K (2017) The Lingering Occurrence of Leprosy in Trinidad in To the 21st Century. J Infect Dis Preve Med 4: 153. doi: 10.4172/2329-8731.1000153

classification for therapeutic purposes into: paucibacillary (PB), 1-5 patches and multibacillary (MB), >5pathces [11], some of the early data was classified using the five-part Ridley-Jopling classification, i.e. beginning with early indeterminant (I) leprosy and continuing with polar tuberculoid (TT) leprosy, borderline tuberculoid (BT) leprosy, mid-borderline (BB) leprosy, borderline lepromatous (BL) leprosy, and polar lepromatous (LL) leprosy [12-15]. In addition where data were available the WHO leprosy disability grading system Table 1, was also used [16]. The highest grade of disability of any of these body sites is used as an overall indicator of the disability status of a person with leprosy. The mid-year population as reported and corrected by each 10 year Census by the Central Statistical Office was used to calculate the annual cumulative incidence rate (CIR) per 10 000 population defined as the number of new cases identified in each calendar year divided by its mid-year population. Disease prevalence defined as the number of patients diagnosed with leprosy and registered for treatment over the course of a year [17], was reported although it can be very sensitive to factors such as treatment duration and case-finding methods [18,19]. Gross Domestic Product (GDP) per capita for Trinidad and Tobago was obtained from the World Bank Annual Reports 1972-2000 [20]. The Mann-Kendall test was used to determine the significance of trends, a p-value of <0.05 was considered significant.

Results

The CIR of leprosy for the 29 year period 1972-2000 was plotted, Figure 1. A peak CIR occurred in 1973 i.e.1.3 per 10 000 population (95% CI 1.1-1.6), Table 2. Subsequently from 1974 the CIR for leprosy in Trinidad declined steadily, realizing a decline of 86%. There were no major outliers except for two small peaks 1994 and 2001; hence no smoothing techniques or transformations were necessary. The Mann-Kendall test was highly significant for trends (p=0.01). In addition the prevalence rate also fell to <1 per 10 000 population. Consequently Trinidad and Tobago (T&T) has met the WHO criterion for the elimination of leprosy i.e. <1 case per 10 000 population since 1974. There were no changes in the demographic characteristics of the population such as change in the age structure, or the ethnic composition over time. In addition there were no aggressive efforts to detect or treat HD. However the GDP per capita tripled from 1118 (USD) in 1972 to 6850 (USD) in 2000, Figure 1 and a significant correlation (p<0.05) between GDP and the decline in incidence of HD was detected. Notwithstanding during the decades of the 1980's and 1990 the incidence rate has remained steady, indicating that leprosy remains endemic in T&T. In the decade of the 1980's the predominant categories were TT (31.6%) and BT (30.6%) while both BL and LL represented 15.8%.

In the first decade of the new millennium the prevalence rate continues below 1 per 10 000 population, Figure 2. However both new cases and the number of cases cured remain steady. A gender

Hands and feet	Eyes
Grade 0 No anaesthesia, no visible deformity or damage	Grade 0 No eye problem due to leprosy; no evidence of visual loss
Grade 1 Anaesthesia present, but no visible deformity or damage	Grade 1 Eye problems due to leprosy present, but vision not severely affected as a result (vision: 6/60 or better; can count fingers at 6 metres).
Grade 2 Visible deformity or damage present	Grade 2 Severe visual impairment (vision worse than 6/60; inability to count fingers at 6 metres); also includes lagophthalmos, iridocyclitis and corneal opacities.

Table 1: WHO grading system.

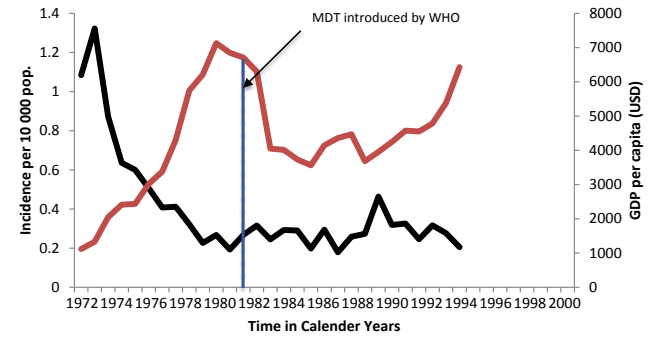

Figure 1: Time series plot of the cumulative incidence rate of Leprosy in Trinidad from 1972-2000 and the corresponding GDP per capita (USD). The vertical line indicating the introduction of Multidrug Therapy (MDT) by WHO in 1982.

Year	Incidence Rate (95% CI)	Year	Incidence Rate (95% CI)	Year	Incidence Rate (95%CI)
1972	1.08(0.89-1.3)	1980	0.32(0.23-0.44)	1990	0.29(0.21-0.4)
1973	1.31(1.1-1.6)	1981	0.23(0.15-0.32	1991	0.18(0.12-0.27)
1974	0.87(0.73-1.1)	1982	0.27(0.18-0.38)	1992	0.26(0.18-0.36)
1975	0.64(0.5-0.8)	1983	0.193(0.124-0.29)	1993	0.27(0.19-0.28)
1976	0.6(0.47-0.76)	1984	0.27(0.19-0.38)	1994	0.46(0.36-0.6)
1977	0.5(0.38-0.65)	1985	0.36(0.23-0.43)	1995	0.32(0.23-0.43)
1978	0.408(0.3-0.54)	1986	0.25(0.17-0.35)	1996	0.32(0.24-0.44)
1979	0.41(0.3-0.54)	1987	0.29(0.2-0.4)	1997	0.25(0.17-0.24)
		1988	0.29(0.2-0.4)	1998	0.32(0.23-0.43)
		1989	0.197(0.13-0.29)	1999	0.28(0.2-0.38)
				2000	0.21(0.14-0.3)

Table 2: Incidence rate of leprosy and 95% Confidence Interval (CI) 1972-2000.

disparity in the distribution of leprosy was noted in which the disease occurred predominantly among men (mean proportion 72%, 95% CI 66-76) in all the years studied. The population of T&T consists of two major diaspora Africans and South East Asians (SEA) both representing approximately 35% of the population. However there was no significant ethnic disparity between the two major ethnic groups. The data recorded only two age groups ≤15 years and >15 years, the predominant age-group affected was among those >15 years. In the decade of the 1980's the predominant categories were TT (31.6%) and BT (30.6%) while both BL and LL represented 15.8%. During the period 2000-2015 the prevalence of MD was higher PB, Table 3.

Discussion

The major finding of this study is an 86% decline in the incidence rate of HD over a seven-year period 1974-1980. Rose contended that the key to understanding incidence lies in 'characteristics of populations and not individuals' and the distinction between the causes of cases and causes of incidence [21]. Clearly in the absence of any major interventions to reduce cases of HD particularly at the individual level the explanation for this decline may be attributed to changes at the population level. Further in 1974, the Canadian Lalonde Report [22] concluded that the health of a population could be considered in four broad domains: human biology, environment, lifestyle, and health-care organization. While human biology and health-care organization can be excluded as possible explanations for this decline the environment and lifestyle have changed. In fact during this period GDP per capita in 1982 ($7130 USD) was 6.4 times greater than 1972 ($1118 USD) a GDP growth of 15.7%. GDP per capita has a close correlation with the trend

Characteristic	2000 n(%)	2001 n(%)	2002 n(%)	2003 n(%)	2004 n(%)	2005 n(%)	2006 n(%)	2007 n(%)	2008 n(%)	2009 n(%)	2010 n(%)	2011 n(%)	2012 n(%)	2013 n(%)	2014 n(%)	2015 n(%)
No of New Cases	26	50	34	29	24	31	28	30	14	26	17	35	26	38	27	30
Incidence Rate (per 10 000 pop) and (95%CI)	0.2 (0.13-0.3)	0.4 (0.3-0.5)	0.3 (0.2-0.4)	0.2 (0.15-0.3)	0.2 (0.15-0.3)	0.2 (0.16-0.3)	0.2 (0.15-0.3)	0.2 (0.15-0.3)	0.1 (0.06-0.17)	0.2 (0.13-0.28)	0.2 (0.14-0.29)	0.3 (0.3-0.4)	0.2 (0.1-0.3)	0.3 (0.2-0.4)	0.2 (0.14-0.29)	0.23 (0.16-0.33)
Total Cases	60	82	119	56	49	46	79	45	38	39	46	84	45	64	98	66
Prevalence Rate (95%CI)	0.7 (0.56-0.85)	0.9 (0.7-1.1)	0.9 (0.78-1.1)	0.65 (0.5-0.7)	0.64 (0.5-0.7)	0.63 (0.5-0.7)	0.61 (0.48-0.75)	0.63 (0.5-0.7)	0.48 (0.4-0.6)	0.49 (0.39-0.63)	0.46 (0.36-0.59)	0.63 (0.5-0.7)	0.33 (0.25-0.45)	0.48 (0.37-0.6)	0.74 (0.6-0.8)	0.51 (0.39-0.61)
Ethnicity																
SEA	13(50)	26(52.2)	14(50)	9(31)	10(41.6)	18(58.1)	13(46.4)	13(43)	8(57)	9(34.6)	5(29.4)	5(14.3)	6(23.1)	17(44.7)	6 (22.2)	13(43.3)
African	11(42)	24(47.8)	14(50)	18(62)	11(45.8)	12(38.7)	10(35.7)	16(53)	4(28)	12(46.2)	5(29.4)	22(62.8)	14(53.8)	12(31.6)	18 (66.7)	9(30)
Other	2(8)	-	-	2(7)	3(12.6)	1(3.2)	5 17.9)	1(4)	2(15)	5 (19.2)	7(41.2)	8(22.9)	6(23.1)	9(23.7)	3 (11.2)	8(26.7)
Gender																
Male	17(65)	37(74)	25(73.5)	20(69.9)	20(82.1)	22(70.1)	17(60.7)	16(53.3)	8(57.1)	15(57.7)	12(70.6)	19(54.3)	17(65.4)	23(60.5)	13(48.2)	20(66.7)
Female	9(35)	13(26)	9(2.5)	9(30.1)	4(17.9)	9(29.9)	11(39.3)	14(46.7)	6(42.9)	11(42.3)	5(29.4)	16(45.7)	9(34.6)	15(39.5)	14(51.8)	10(33.3)
Grade																
1	5(19.2)	10(20)	5(22.4)	5(17.2)	1(4.2)	14(45.2)	3(10.7)	3(10)	2(14.2)	4(15.4)	3(17.6)	9(25.7)	5(19.2)	7(18.4)	4(4.8)	6(20)
2	2(7.7)	2(4)	1(3)	4(13.8)	1(4.2)	3(9.7)	2(7.1)	1(3.3)	2(14.2)	2(7.6)	0(0)	2(5.7)	3(11.5)	2(5.2)	2(7.4)	3(10)
Clinical (all cases)																
PB	25(28.5)	27(50)	19(51.4)	15(26.8)	10(25.6)	11(23.9)	14(50)	14(46.7)	5(35.7)	10(38.5)	17(27)	15(42.9)	4(15.4)	16 (42.1)	13 (42.1)	17(56.7)
MB	63(71.5)	27(50)	18(48.6)	41(73.2)	39(74.4)	35(76.1)	14(50)	16(53.3)	9(64.3)	16(61.5)	46(73)	20(57.1)	22(84.6)	22 (57.8)	14 (5.9)	13 (43.3)
Age (all cases)																
<15	0(0)	7(8.5)	5(4.2)	3(5.4)	6(12.2)	4(8.7)	3(3.8)	1(2.2)	3(7.9)	3(7.7)	13(28.2)	1(1.2)	3 (6.7)	6 (9.4)	2 (2.1)	4(6.1)
>15	60(100)	75(91.5)	114(95.8)	53(94.6)	43(87.8)	42(91.3	76(96.2)	44(97.8)	35(92.1)	36(92.3)	33(71.8)	83(98.8)	42(93.3)	58(90.6)	96 (97.9)	62 (93.9)

[1]Prevalence rate per 10 000 population

Table 3: Epidemiological characteristics of leprosy, 2000-2015.

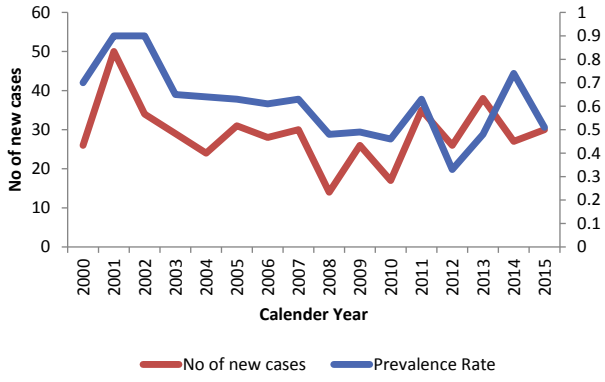

Figure 2: Number of new leprosy cases, and prevalence rate per 10 000 population (Pop.) by year for the period 2000-2015.

in living standards over time, and the GDP growth rate is probably the single best indicator of economic growth. Therefore the decline in HD may be attributed to environmental and lifestyle changes occurring at the population level.

On the other hand over the span of two decades 1980-1989 and 1990-1999 there is a lack of a parallel decline in HD incidence. From 1980 through 2015, the annual new case detection rate has persistently remained at approximately 0.3 per 10 000 population annually. This finding suggests that no single factor acting alone will result in the total elimination of HD and raises the issue as to whether current chemotherapy efforts will break the chain of disease transmission. In addition fundamental issues such as the disease reservoir(s), mechanism of disease transmission, and inability to screen for latent or subclinical disease among the most vulnerable are factors that continue to contribute to disease occurrence. This is against a background of the current WHO strategy for controlling leprosy, which is based on the implementation of effective drug regimens. We provide evidence that although antibiotic treatment has been available the decline in cases observed occurred before multidrug therapy was instituted in 1982 (Figure 1) and subsequently has had little effect on reducing the annual incidence of new cases of HD, strengthening our argument in support of improving economic growth. Additionally, recent reports have shown that relapse rates of 16% to 39% among MB patients with high bacteriologic index (BI) are appearing 4 to 10 years after completion of 2-year multidrug therapy [23-25]. Notwith standing no infectious disease has been eliminated using drug treatment alone, without an effective vaccine. However both the development and the difficulties of delivering an effective leprosy vaccine will pose profound challenges. Therefore elimination as a strategic goal will still require early diagnosis, in order to try to interrupt transmission with treatment as early as possible, improved health service and better standards of living, all of which represent huge challenges for developing countries in the 21st century. In this regard basic clinical training and skill as well as access to qualified diagnostic laboratory services remain basic essentials.

In the 1980's approximately one-third of all cases were tuberculoid. These lesions are frequently scaly, dry, hairless and anaesthetic particularly in black populations. The anaesthesia is due to destruction of dermal nerve fibers. This form carries a good prognosis and lesions will often self-heal. Damage to peripheral nerves is limited. In order both to raise awareness of lingering cases of HD and to increase detection all physicians should either refer suspected patients to a dermatology center or test for anaesthesia. On the other hand lepromatous disease represented only 15% of the cases. Lepromatous disease may be present for many years before diagnosis, and is characterized by a greater array of features such as peripheral oedema, hair loss (madarosis), 'leonine facies', nasal and laryngeal lesions, testicular atrophy [26], and glove and stocking neuropathy [27] which may occur among several easily examinable nerves including the posterior tibial nerve, ulnar, median, lateral popliteal and facial nerves [28].

Data for the first decade of the 21srt century shows that MB was more prevalent than PB. In 1982, the World Health Organization (WHO) [28] advocated the use of 2 different regimens of multidrug therapy for the treatment of leprosy. Treatment regimens were originally assigned on the basis of the Ridley-Jopling classification [12]. Under this method of classification, a BI value ≥ 2 at any skin site indicated therapy for MB leprosy and a BI value <2 indicated therapy for PB leprosy. By 1988, a positive skin-smear result at any site became sufficient to indicate treatment for MB leprosy [29,30]. However due to lack of resources and the reliability of histopathological analysis and skin-smear results, the WHO has recently advocated the field-friendly method of counting skin lesions to determine whether patients should be treated for PB or MB leprosy (PB leprosy, ≤ 5 lesions; MB leprosy, >5 lesions) [31]. This however has raised several concerns including misclassification with the potential to result in drug resistance and relapse and it prolongs the time the patient is infective. Dasananjali and colleagues in Thailand [32] have provided evidence that the risk of relapse was highest in patients with MB leprosy who were wrongly classified as having PB leprosy and were undertreated.

The findings of this current study showed that the proportion of new leprosy patients with disability was 21.4% grade-1 and 7.1% grade-2. Moreover, new cases with Grade 2 disability (G2D) remain unchanged between 2000-2010, reflecting a failure in early leprosy detection. In addition in 2009 WHO launched the Enhanced Global strategy for further reducing the disease burden due to leprosy for 2011-2015, with a target to reduce the number of new cases with grade-2 disability per 100000 population by at least 35% between the end of 2010 and the end of 2015 instead of leprosy prevalence [10]. The findings of this study suggest that we have not met this target.

The findings in this study are subject to at least two limitations. First, data are limited to those patients captured by the MoH Leprosy Unit. On the other hand the unit apart from collecting data on diagnoses also provides free treatment, follow up care and support to patients, and hence can provide a reliable estimate of leprosy in Trinidad. Second, data regarding the onset of symptoms are limited by patient recall. Notwithstanding the data is more than likely to represent the true incidence rate, as very small if any cases are managed in the private health care system apart from the MoH.

In conclusion leprosy in Trinidad is curable but is yet not preventable, and leprosy remains a major global health problem. Elimination of a disease such as leprosy will be difficult to achieve, partly because of a long, variable incubation period and much remains unknown about its biology. Although it is one of the oldest diseases known to man, critical gaps remain in our basic understanding of this disease, including transmission and pathogenesis. Notwithstanding substantial progress has been made in providing treatment to those with leprosy, although further developments are needed. Future progress toward eradicating leprosy is dependent on a better understanding of the disease transmission and new tools to interrupt it.

References

1. Han XY, Seo YH, Sizer KC, Taylor S, May GS, et al. (2008) A new *Mycobacterium* species causing diffuse lepromatous leprosy. Am J Clin Pathol 130: 856–864.
2. Manchester K, Knusel C (1994) A medieval sculpture of leprosy in the Cistercian Abbaye de Cadouin. Med Hist 38: 204-206.
3. Shepard CC (1960) "Acid-fast bacilli in nasal excretions in leprosy, and results of inoculation of mice". Am J Hyg 71: 147-157.
4. Pedley JC (1973) "The nasal mucus in leprosy". Lepr Rev 44: 33-35.
5. Davey TF, Rees RJW (1974) "The nasal discharge in leprosy: clinical and bacteriological aspects". Lepr Rev 45: 121-134.
6. Rees RJW, McDougall AC (1977) "Airborne infection with Mycobacterium leprae in mice". J Med Microbiol 10: 63-68.
7. Chehl S, Job CK, Hastings RC (1985) "Transmission of leprosy in nude mice". Am J Trop Med Hyg 34: 1161-1166.
8. Davey TF, Rees RJ (1974) The nasal dicharge in leprosy: clinical and bacteriological aspects. Lepr Rev 45:121-134.
9. Global Leprosy Situation (2012) Weekly epidemiological record. 87: 317–328.
10. Global Health Observatory WHO.
11. World Health Organization (2009) Enhanced global strategy for further reducing the disease burden due to leprosy (plan period: 2011–2015), New Delhi. searo.who.int/LinkFiles/GLP_SEA-GLP-2009_3.pdf, accessed August 2013.
12. Ridley DS, Jopling WH (1966) Classfication of leprosy according to immunity: a five-group system. Int J Lepr Other Mycobact Dis 34: 255-273.
13. Scollard DM, Adams LB, Gillis TP, Krahenbuhl JL, Truman RW, et al. (2006) The continuing challenges of leprosy. Clin Microbiol Rev 19: 338-381.
14. Bullock W (1988) Leprosy (Hansen's disease) In: Wyngaarden JB, Smith LH, editors. Cecil textbook of medicine. 18th ed. Philadelphia: 1696–1701.
15. Suzuki K, Akama T, Kawashima A, Yoshihara A, Yotsu RR, et al. (2012) Current status of leprosy: epidemiology, basic science and clinical perspectives. J dermatol 39: 121-129.
16. Britton WJ, Lockwood DN (2004) Leprosy. Lancet 363: 1209-1219.
17. Durrheim DN, Speare R (2003) Global leprosy elimination: time to change more than the elimination target date. J Epidemiol Community Health 57: 316-317.
18. Smith C, Richardus JH (2008) Leprosy strategy is about control, not eradication. Lancet 371: 969-970.
19. Brandsma JW, Van Brakel WH (2003) WHO disability grading: operational definitions. Lepr Rev 74: 366-373.
20. The World Bank Annual Reports. worldbank.org
21. Rose G (1985) Sick individuals and sick populations. Int J Epidemiol 30: 427–432.
22. Lalonde M (1974) A new perspective on the health of Canadians. A working document. Ottawa, Ontario: Government of Canada.
23. Gelber RH, Balagon VF, Cellona RV (2004) The relapse rate in MB leprosy patients treated with 2-years of WHO-MDT is not low. Int J Lepr Other Mycobact Dis 72: 493-500.
24. Girdhar BK, Girdhar A, Kumar A (2000) Relapses in multibacillary leprosy patients: effect of length of therapy. Lepr Rev 71:144-153.
25. Jamet P, Ji B (1995) Relapse after long-term follow up of multibacillary patients treated by WHO multidrug regimen. Marchoux Chemotherapy Study Group.Int J Lepr Other Mycobact Dis 63: 195-201.
26. Ishikawa A, Ishikawa S, Hirakawa M (2001) steoporosis, bone turnover and hypogonadism in elderly men with treated leprosy. Lepr Rev 72: 322-329.
27. Pocaterra L, Jain S, Reddy R (2006) Clinical course of erythema nodosum leprosum: an 11-year cohort study in Hyderabad, India. Am J Trop Med Hyg 74: 868-879.
28. Croft RP, Richardus JH, Nicholls PG, Smith WC (1999) Nerve function impairment in leprosy: design, methodology, and intake status of a prospective cohort study of 2664 new leprosy cases in Bangladesh (The Bangladesh Acute Nerve Damage Study). Lepr Rev 70:140-159.
29. World Health Organization (1982) WHO Technical Report Series, Geneva Chemotherapy of leprosy for control programmes.
30. World Health Organization (1988) WHO Expert Committee on Leprosy: 6th report. WHO Technical Report Series, no. Geneva World Health Organization.
31. World Health Organization (1995) Guide to eliminate leprosy as a public health problem, Geneva: World Health Organization.
32. Dasananjali K, Schreuder PA, Pirayavaraporn C (1997) A study on the effectiveness and safety of the WHO/MDT regimen in the northeast of Thailand; a prospective study, 1984–1996. Int J Lepr Other Mycobact Dis 65: 28-36.