THE CLINICAL PROFILE AND ASSOCIATIONS OF TUBERCULOSIS AMONG HEALTH CARE WORKERS IN SOUTH INDIA.

A

Dissertation done towards partial fulfillment of the requirements of the

Tamil Nadu Dr. M. G. R. Medical University, **Chennai** for the

M.D.(Branch – I)(General Medicine) exams to be conducted in

February/ March 2006

CERTIFICATE

This is to certify that this thesis "**The Risk Factors for Tuberculosis among Health Care Workers in South India**" done towards partial fulfillment of the requirements of the **Tamil Nadu Dr. M. G. R. Medical University**, Chennai for the **M.D. (Branch – I) (General Medicine)** exams to be conducted in February / March 2006, is a bonafide work of the candidate **Dr. Anoop Mathew.** It was performed in the Christian Medical College, Vellore under my guidance and supervision.

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INTRODUCTION

Every year 1.8 million people in India develop tuberculosis (TB). India accounts for one-fifth of the global TB incidence and is estimated to have the highest number of active TB cases amongst the countries of the world. Many hospitals in India handle large number of tuberculosis cases. The emergence of multidrug resistant tuberculosis has been reported to have caused outbreaks among health care workers in many hospitals. Various authorities have recommended measures to prevent the nosocomial transmission of tuberculosis. However scientific data demonstrating the efficacy of these measures is lacking. Delayed diagnosis of active pulmonary TB among hospitalized patients is common and believed to contribute significantly to nosocomial transmission. Various studies reported a risk of infection among workers exposed to patients with tuberculosis that was four to six times higher than the risk among unexposed workers. However the risk of tuberculosis among health care workers varies considerably among and within hospitals.

Epidemiological studies are needed to identify the high-risk subgroups among health care workers and to identify potential risk factors for transmission of disease. Such observations would lead to further implementation of cost effective infection control measures and analysis of the efficacy of such measures with respect to developing countries like India. These measures might prevent or retard the nosocomial transmission of tuberculosis to both patients and to health care workers.

AIMS AND OBJECTIVES

OBJECTIVES:

1. To identify the risk factors for acquiring tuberculosis among health care workers at a tertiary level teaching hospital in South India.

2. To determine the incidence of tuberculosis among health care workers.

3. To identify the factors associated with a delay in the diagnosis of tuberculosis among health care workers.

REVIEW OF LITERATURE

The risk of tuberculosis among health care workers was substantial in the pre-antibiotic era (1), but declined rapidly after 1950 in the West because of the lower incidence of the disease in the population and with the advent of effective therapy. Over the past decade two factors have profoundly altered views about the risk of tuberculosis in health care workers. First is the resurgence of the disease in developed countries and inability to control the disease adequately in many developing countries. Epidemiological surveys recently carried out in northern India have found a prevalence of tuberculosis infection to be at 10.3% (95%CI 8.4- 12.2).The annual risk of infection computed from the estimated prevalence was 1.9%. In urban areas the prevalence of infection was 14.1% with an annual risk of transmission of 2.6%. This survey was based on the frequency distribution of tuberculin skin reaction size among 25,816 children without a BCG scar (2). In some US cities the incidence has more than doubled (3). The second factor is the emergence of multidrug resistant tuberculosis, which has been reported to have caused outbreaks in at least 12 hospitals in the US (4, 5, 6). In these outbreaks 18 to 35 % of the exposed health care workers have had documented conversion on tuberculin testing (5, 6, 7). At least 17 health care workers have had active multidrug resistant tuberculosis and five have died (8). In addition, health care workers infected with the human immunodeficiency virus (HIV) are more susceptible to tuberculosis than those without HIV infection. Various authorities have recommended measures to prevent the nosocomial transmission of tuberculosis (9, 10). However scientific data demonstrating the

efficacy of these measures is lacking (11). The recommendations of CDC, Atlanta (12) have been criticized because their implementation would require massive expenditure in all hospitals that admit patients with tuberculosis (14).

BURDEN OF DISEASE

Every year 1.8 million people in India develop tuberculosis (TB). India accounts for one-fifth of the global TB incidence and is estimated to have the highest number of active TB cases amongst the countries of the world. The nationwide Annual Risk of TB Infection (ARTI) survey, completed in 2003, showed that each year 75 new smear positive pulmonary TB cases occur per 100,000 population, with a higher incidence in the northern states and in the urban population. An increasing morbidity and mortality from tuberculosis in the near future is forecast for the world at large, with the number of newly occurring cases predicted to increase from 7.5 million a year in 1990 to 8.8, 10.2 and 11.9 million in the years 1995, 2002 and 2005 respectively; an increase amounting to 58.6 per cent over a 15-yr period (13). The estimates were subsequently found to be appropriate for the year 2000 using a new method. The proportion of tuberculosis cases co-infected with human immunodeficiency virus (HIV) was also found to be rising, being 2-10 times greater for the 1997 estimates, than for 1990. The association with HIV and increasing multi drug resistant tuberculosis (MDRTB) appears to be a serious issue, especially for the developing nations. India is classified along with the sub-Saharan African countries to be among those with a high burden and the least prospects of a favourable time trend of the disease as of now (Group IV countries). The average prevalence of all forms of

tuberculosis in India is estimated to be 5.05 per thousand, prevalence of smear-positive cases 2.27 per thousand and average annual incidence of smear-positive cases at 84 per 1,00,000 annually.

Recent studies: Annual risk of infection (ARI) in various areas in India

	Study by	State	Year	ARI (%)
1.	Kerala TB Association	Kerala[30]	1991	0.75
2.	NTI	Tumkur Dist[14]	1960-72	1.66-1.08
		Bangalore Rural[14]	1962	1.1
		Bangalore Rural[14]	1985	0.61
		Bangalore Urban[22]	1996-99	1.67
		*North India	2000-01	1.9
		North India rural		1.62
		North India urban		2.6
3.	TRC, Chennai	Chingleput (Rural)[21]	1969-84	1.8-1.9
		Chingleput (Rural)[21]	1991-96	2.9-3.2
4.	URMUL Trust	Rajasthan[14]		1.44
5.	DAN TAB (DANIDA)	*Orissa	2002	1.72
		Orissa Rural		1.62
		Orissa Urban		2.48
6.	A & N Govt.	Car Nicobar[14]	1986	1.53
7.	RMRC, Port Blair	Car Nicobar[23]	2002	3.8
8.	MGIMS, Sevagram/ NTI, Bangalore	Maharashtra[31]		
		Nagpur Rural	2001	1.2 (6.34-6.38)
		Nagpur Urban	2001	1.6 (8.44-8.50)
		Thane Rural	2001	1.6 (8.07-8.10)
		Thane Urban	2001	3.3 (15.75-15.80)

95 per cent confidence interval (CI) of prevalence of infection is given in parentheses
*Personal information, unpublished data. NTI
NTI, National Tuberculosis Institute; TRC, Tuberculosis Research Centre;
URMUL, Upper Rajasthan Milk Union Ltd. Lunkaransahr; DAN TAB DANIDA-DANIDA TUBERCULOSIS
A & N, Andaman & Nicobar; RMRC, Regional Medical Research Centre, Port Blair;
MGIMS, Mahatma Gandhi Institute of Medical Sciences, Sevagram

INCIDENCE OF TUBERCULOSIS DISEASE AMONG HEALTH CARE WORKERS:

The epidemiology of tuberculosis among health care workers in developing countries which have hospitals handling large number of tuberculosis inpatients and outpatients is largely unknown. A recent study from Istanbul, Turkey, performed by Cagar et al revealed an increased risk of tuberculosis among HCWs. The mean incidence of tuberculosis in that study was 96 per 100,000 for all HCWs with a relative risk of 2.71 compared to the general

population (15). The incidence rates were higher in the departments of chest diseases (151 per 100,000) and medicine (157 per 100,000). The mean incidence of tuberculosis for Turkey was 35.4 per 100,000. This again was a retrospective study based on hospital records. Higher incidence of tuberculosis among health care workers has been demonstrated in countries like Estonia, Malawi and Serbia. In the study done in Malawi the annual case rate was found to be nearly 12 times higher than the rate of tuberculosis in the general adult population aged more than /equal to 15 years, with a relative risk of 11.9 (95% CI 9.8- 14.4). 3.6% of the HCWs were registered and treated for tuberculosis. The rates were especially higher for certain subgroups like clinical officers (7.6%) possibly due to greater contact with the cases. The results of this study may not be applicable to India due to the higher prevalence of HIV among the HCWs in Malawi (16). Very few cohort studies have been conducted on tuberculosis among HCWs. Cohort studies conducted in the preantibiotic era found a significantly increased risk of disease among health care workers (17).

A recent cohort study conducted in Hong Kong revealed surprisingly no excess risk of tuberculosis among health care workers as compared to the general population (18). Studies from disease registries have reported an estimated risk ratio of 0.6 to 2.0, indicating a modest increase of risk for tuberculosis among HCWs. Both cohort and disease-registry studies may be limited by the inability to distinguish occupational from nonoccupational exposure. These studies may underestimate the risk because of the failure to standardize for age or because the working population is younger and has a

lower incidence of tuberculosis than the general population (the “healthy-worker effect”) (19). Disease-registry studies may misclassify exposure because the information on occupation is incomplete or workers have changed jobs between the time of exposure and the development of the disease. Questionnaire studies of workers at the highest risk can estimate exposure more precisely. A series of questionnaire surveys of British laboratory workers detected an increased risk of disease among microbiology technicians until 1971, but between 1979 and 1989 this increase largely disappeared. The risk remained persistently elevated for technicians involved in histology preparation and autopsies (20).

A study in Japan reported the incidence of tuberculosis was 6 to 11 times higher among pathologists and pathology technicians than in the unexposed population (21). Two surveys of physicians reported substantial rates of tuberculous infection and disease, particularly among physicians between 20 and 35 years of age and those in internal medicine specialties. (22, 23) The accuracy of data from questionnaire studies may be limited by recall or selection biases and such biases could have resulted in an overestimate of the risk of tuberculosis among physicians in these two studies, since only 60 to 69 percent of those surveyed returned the questionnaires.

This highlights the importance of further research in order to redefine the risk levels and to identify high risk population subgroups among HCWs. There is a paucity of data from the Indian subcontinent in this field.

Table 1. Incidence of Tuberculous Disease in Health Care Workers.

Study	**Period**	**Location**	**Population**	**Type of study**	**Incidence** (per 100,000 person years)
Hosoglu Set al	1986-2000	Turkey	all HCWs	Registry	199.9
Skodric V et al	1986-1997	Serbia	HCWs employed at Institute for Pulmonary Diseases	Registry	3451
Dimitrova B et al	1994-2002	Russia	HCWs employed at the TB services	Registry	741.6
Jelip J et al	1990-2000	Malaysia	all HCWs	Registry	280.4
Geiseler et al.	1938–1974	Chicago	Physicians	Questionnaire	140
Barrett-Connor	1946–1975	California	Physicians	Questionnaire	3800
Kwan et al.	1957–1987	Hong Kong	all HCWs	Cohort	393
Ashley and Wigle	1966–1969	Ontario	all HCWs	Registry	33
Burrill et al.	1969–1979	British Columbia	Nurses	Registry	26
Harrington and Shannon	1971	Britain	Medical laboratory workers	Questionnaire	110
Capewell et al.	1978–1983	Scotland	National Health Service staff	Registry	11
Grist and Emslie and Grist	1979–1989	Britain	Laboratory workers	Questionnaire	27
Yanai H et al	2001	Malawi	all HCWs	Registry	5780
Cuhadaroglu C et al	1991-2000	Turkey	all HCWs	Questionnaire	96
Yanai H et al	1995–1999	Thailand	all HCWs	Cohort	536

ESTIMATES OF THE RISK OF TUBERCULOUS INFECTION AMONG HEALTH CARE WORKERS

In the era before antibiotics were available, the annual risk of infection among health care workers was as high as 80 percent (17).Studies conducted in the 1960s reported a risk of infection among workers exposed to patients with tuberculosis that was four to six times higher than the risk among unexposed workers (24). Studies reveal that in institutions with fewer than 10 admissions for tuberculosis annually or less than 1 admission per year per 100 workers, the risk of infection was less than 0.2 percent (25). In one hospital with 155 workers per admission for tuberculosis per year, the risk of infection was 1.4 percent (26).This higher conversion rate was attributed to immunologic boosting, because conversions on tuberculin testing were associated with older age but not with exposure. In one study the prevalence of infection was directly proportional to the duration of employment in the hospital. In four studies in which the ratio of the number of workers to the annual number of admissions for tuberculosis was between 18 and 92, the annual risk of infection ranged from 1.7 to 3.9 percent (24,27,28) and was correlated with actual exposure in two of the institutions(27,28). In hospitals where there were more than 200 admissions annually for tuberculosis or where the ratio of workers to annual admissions was less than 10, infection occurred in 1 to 10 percent of workers each year. None of the studies included an appropriate control group with similar nonoccupational exposure to tuberculosis. Among these only one study performed initial two-step

testing to account for the booster effect, the prevalence of which may vary considerably among different populations (29,30).

Recently Mycobacterium tuberculosis infection in HCWs has been studied in developing countries using newer diagnostic tests. Latent tuberculosis infection prevalence in health care workers have been estimated using the tuberculin skin test (TST) and a whole-blood interferon gamma (IFN-gamma) assay in a recent study in India. Pai et al showed that a large proportion of the health care workers were latently infected; 360 (50%) were positive by either TST or IFN-gamma assay, and 226 (31%) were positive by both tests. The prevalence estimates of TST and IFN-gamma assay positivity were comparable (41%; 95% confidence interval [CI], 38%-45% and 40%; 95% CI, 37%-43%, respectively). Agreement between the tests was high (81.4%; kappa = 0.61; 95% CI, 0.56-0.67). BCG vaccination had little impact on TST and IFN-gamma assay results (31). The utility of tuberculin skin testing in developing countries with high prevalence of bacille Calmette-Guerin (BCG) vaccination has been studied. Tan et al showed that a TST cut-off point of 15 mm or greater may correlate better with M. tuberculosis infection than a cut-off point of 10 mm or greater in settings with a high prevalence of BCG vaccination. In their study 52.1% and 26.2% of the HCWs tested had indurations of 10 mm or greater and 15 mm or greater, respectively (32). However it has been shown that infections with non-tuberculous mycobacteria are responsible for the majority of 5-14 mm PPD reactions among US-born health care workers and medical students subject to annual tuberculin testing. This study used skin testing with Mycobacterium avium

sensitin (MAS) to determine contemporary rates of infection with non-tuberculous mycobacteria (NTM) and their effect on reactions to M. tuberculosis purified protein derivative (PPD). MAS dominant reactions were found in 82% of subjects with 5-9 mm PPD reactions and 50% with 10-14 mm PPD reactions; these reactions were more common among whites (P = 0.046), US-born (P = 0.038) and subjects without BCG immunization (P = 0.004) (38).

Table 2. Incidence of Tuberculous Infection in Health Care Workers

Study	**period**	**location**	**population**	**measure**	**Incidence** (per 100 person-years)	**prevalence**
YanaiHet al	1999	Thailand	All HCWs	Mantoux	2.2	___
Larsen NM et al	1994-1998	United States	All HCWs	Mantoux	0.38	___
Berman et al.	1971–1976	Baltimore	All HCWs	Tine	1.4	___
Craven et al	1972–1973	Virginia	All HCWs	Mantoux	1.7	___
Vogeler and Burke	1972–1977	Utah	All HCWs	Tine	0.11	___
Ruben et al.	1973–1975	Pittsburgh	All HCWs	Mantoux	3.9	___
Chan and Tabak	1978–1981	Miami	House staff	Mantoux	4.0	___
Price et al.	1980–1984	N. Carolina	All HCWs	Mantoux	1.1	___
Aitken et al.	1982–1984	Washington State	All HCWs	Mantoux	0.09	___
Raad et al.	1984–1987	N. Florida	All HCWs	Mantoux	0.12	___
StuartRLet al	1996-1999	Melbourne	All HCWs	Mantoux	___	19.3%
Kassim S et al	1996-1997	Cote d'Ivoire	All HCWs	Mantoux	___	79%
Tan LH et al	2002	Malaysia	medical, surgical, and orthopedic ward HCWs.	Mantoux	___	52.1%
Pai M et al	2004	India	All HCWs	Mantoux and IFN-gamma assay	___	50%

RISK FACTORS FOR TUBERCULOSIS IN HEALTH CARE WORKERS

In the study performed by Tan et al in Malaysia, medical ward HCWs were at significantly higher risk of a positive TST reaction than were surgical or orthopedic ward HCWs (odds ratio, 2.18; 95% confidence interval, 1.33 to 3.57; p = .002 for TST positivity at 10 mm or greater) (odds ratio, 2.61; 95% confidence interval, 1.44 to 4.70; P = .002 for TST positivity at 15 mm or greater). A previous TST was a significant risk factor for a positive TST reaction at either 10 mm or greater or 15 mm or greater, but a duration of employment of more than 1 year and being a nurse were only significantly associated with a positive TST reaction at a cut-off point of 15 mm or greater (32). Pai et al showed that increasing age and years in the health profession were significant risk factors for both IFN-gamma assay and TST positivity (31).

However non-occupational factors also may play an important role in TST conversion in the health care setting. A prospective observational cohort study was conducted by Larsen et al to assess rates of and risk factors for TST conversion among HCWs was at an urban hospital located in a high tuberculosis-incidence area over four years. All hospital employees undergoing required testing every 6 months were included. A total of 69 (1.2%) of 5773 susceptible employees had a documented TST conversion (overall rate, 0.38 per 100 person-years worked). No significant difference existed in conversion rates among employees with frequent, limited, or no patient contact. HCWs with a TST conversion lived in zip codes with higher tuberculosis case rates ($P<0.05$). In multivariate analysis, TST conversion was associated with history of bacille

Calmette-Guerin vaccination (relative risk [RR], 11.63), annual salary < $20,000 (RR, 3.67), and increasing age. In the setting of an effective tuberculosis infection-control program, TST conversion rates were low, and risk of conversion among HCWs was associated most strongly with nonoccupational factors.

NOSOCOMIAL TRANSMISSION OF TUBERCULOSIS

Contributing factors in the reports of outbreaks related to single patients were delayed diagnosis (in the majority); poor ventilation with positive pressure in isolation rooms or high levels of air recirculation (or both); and aerosolization of bacilli through mechanical ventilation, bronchoscopy, dressing change, jet irrigation of a thigh abscess, or autopsy. Transmission during autopsy occurred despite a ventilation rate of 11 air changes per hour, suggesting massive aerosolization of infectious particles, which may explain why workers who assist in autopsies have higher rates of disease than other health care workers. In recent reports of hospital outbreaks of tuberculosis with transmission to health care workers, common factors were delayed diagnosis of disease, drug-resistant strains, and multiple lapses in administrative, engineering, and personal infection-control practices. Such lapses involved booths used for the dispensing of aerosolized pentamidine or for sputum induction, isolation rooms with positive pressure in relation to the pressure in the corridor and recirculating ventilation, as well as inadequate use of masks by health care workers going into isolation rooms or by patients coming out of them.

In the 1930s Wells demonstrated that patients with active pulmonary tuberculosis expelled small droplets containing tubercle bacilli. These droplets rapidly evaporated to form droplet nuclei 1 to 5 micrometers in size which would remain airborne and viable for several days (33).In susceptible guinea pigs inhalation of as less a quantity as a single droplet nuclei containing no more than 3 tubercle bacilli have resulted in infection (34). Hence based on these findings health agencies have said that there is no permissible level of exposure to tuberculosis (35).

EVIDENCE IN SUPPORT OF RECOMMENDED CONTROL MEASURES

Diagnosis and Therapy

The evidence in support of recommended infection control measures have to be critically analyzed. Delayed diagnosis of active pulmonary TB among hospitalized patients is common and believed to contribute significantly to nosocomial transmission. A study was conducted to define the occurrence, associated patient risk factors, and outcomes among patients and exposed workers of delayed diagnosis of active pulmonary TB (60). Among 429 patients newly diagnosed to have active pulmonary TB over a period of three years in 17 acute-care hospitals in four Canadian cities, initiation of appropriate treatment was delayed 1 week or more in 127 (30%). This was associated with atypical clinical and demographic patient characteristics, and after adjustment for these characteristics, with admission to hospitals with low TB admission rate of 0.2-3.3 per 10,000 admissions (odds ratio: 7.4; 95% confidence interval: 3.2,17.5)

or intermediate TB admissions of 3.4-9.9/10,000 (OR: 2.3; CI: 1.6,3.2) as well as potentially preventable (late) intensive care unit admission (OR: 16.8; CI: 2.0,144) and death (OR: 3.3; CI: 1.7,6.5). In hospitals with low TB admission rates, initially missed diagnosis, smear-positive patients undergoing bronchoscopy, late intensive care unit admission (OR: 2.3; CI: 0.1,56), and death (OR: 3.8; CI: 1.2,12.1) were more common than in hospitals with high TB admissions (> 10/ 10,000); a similar trend was seen in hospitals with intermediate TB admissions. Even after adjustment for workers' characteristics and ventilation in patients' rooms tuberculin conversions were disproportionately high in hospitals with low and intermediate TB admission rates and significantly higher in hospitals with overall TB mortality rate above 10% (OR: 2.5; CI: 1.6,3.7). In the hospitals studied, as the rate of TB admissions decreased, the likelihood of poor outcomes and risk of transmission of TB infection per hospitalized patient with TB increased. Institutional risk of TB transmission was poorly correlated with number of patients with TB and better correlated with indicators of patient care such as delayed diagnosis and treatment and overall TB-related patient mortality (60).

R. Rajeswari et al from the Tuberculosis Research Centre (TRC), Chennai investigated the factors associated with delay in care-seeking (patient delay), and diagnosis by health providers (health system delay), among smear-positive tuberculosis patients, before large-scale DOTS implementation in South India. Among 531 participants, the median patient, health system and total delays were 20, 23 and 60 days, respectively. Twenty-nine per cent of patients delayed seeking care for one month, of whom 40% attributed the delay to their lack of

awareness about TB. Men postponed seeking care for longer periods than women (*P*=0.07). In multivariate analysis, the patient delay was greater if the patient had initially consulted a government provider (adjusted odds ratio [AOR] 2.2, *P* =0.001), resided at a distance two km from a health facility (AOR 1.6, *P* = 0.04), and was an alcoholic (AOR 1.6, *P* = 0.04). Health system delay was seven days among 69% of patients. Factors associated with health system delay were: first consultation with a private provider AOR 4.0, *P*=0.001), a shorter duration of cough AOR 2.6, *P* = 0.001), alcoholism (*P*=0.04) and patient's residence two km from a health facility (AOR 1.8, *P* = 0.02). The total delay resulted largely from a long patient delay when government providers were consulted first and a long health system delay when private providers were consulted first (59).

The rates of nosocomial transmission of tuberculosis is the highest when the diagnosis of tuberculosis in hospitalized patients is delayed; when patients do not receive adequate therapy; and when there is unrecognized drug resistance among the mycobacterial strains. Many of these factors coexist in hospitals in developing countries, making them conducive for the nosocomial transmission of tuberculosis both to heath care workers and to patients. In four retrospective cohort studies, diagnosis was delayed in 40 to 50 percent of all patients with active tuberculosis (36) for an average of six days, which resulted in the exposure of 27 to 44 workers for each patient with undiagnosed disease. The delay in the diagnosis may be due to lack of awareness by physicians, atypical clinical manifestations, or inadequate diagnostic facilities.

Ventilation:

The only epidemiologic evidence of the effect of ventilation on nosocomial transmission of tuberculosis is from reports on outbreaks in which recirculating or inadequate (37, 38) ventilation was identified as a contributory factor. In a study by the Canadian Collaborative group in nosocomial transmission of tuberculosis, inadequate ventilation in general patient rooms was identified as a risk factor with an adjusted Hazard ratio of 3.4 (for less than two air exchanges per hour)(39). Engineering standards, including standards of ventilation recommended by the CDC have not been met in the vast majority of hospitals in developing countries. Implementation of the recommended standards for ventilation would increase energy costs substantially in all hospitals and require frequent inspection and maintenance. Many hospitals would have to install new ventilation systems or upgrade existing systems.

Ultraviolet Light

Properly installed, ultraviolet light has a germicidal efficacy equivalent to 17 air changes per hour (40). Less than 5 percent of the ultraviolet light penetrates the skin, so the risk of cataracts or skin cancer should be nil.

Masks

The efficacy of standard surgical masks in preventing the inhalation of droplet nuclei with a diameter of 1 to 5 mm is less than 50 percent. Since 1990, the Centers for Disease Control and Prevention (CDC) have recommended the use of particulate respirators (41). These include dust–mist masks, which are

tested to filter 99 percent of 40 to 50 mg of silica dust; dust–mist–fume masks, tested to filter 99 percent of a lead-fume aerosol; and high-efficiency particulate air filters (HEPA masks), tested to filter 99.97 percent of 0.3-mm particles. Thus, only HEPA masks are tested in a way that can ensure protection against tuberculosis (i.e., protection from droplet nuclei that are 1 to 5 mm in diameter). HEPA masks are recommended by the Occupational Safety and Health Administration of United States in part because of the absence of appropriate testing of other filters. A HEPA mask costs $ 9.08 .The suitability and cost effectiveness of these masks have not been proved conclusively. Biscotto et al evaluated N95 respirator use as a tuberculosis control measure in a resource-limited setting. The study evaluated the use of personal respiratory protection by HCWs as a measure to reduce TB occupational risk. One hundred and forty-five HCWs were randomly observed for the use of a N95 respirator when entering high-risk areas or performing high-risk procedures. N95 respirators were infrequently used, even for high-risk procedures such as endotracheal intubation (25%) and respiratory aspiration (12%), and in high-risk areas such as the pulmonary medicine ward (69.2%), emergency department (29.5%), intensive care unit (8.8%), and TB room isolation (39.5%). Facial-seal leakage was observed in 39% of HCWs due to failure to wear the mask with a tight facial fit as directed. Respirator use as a sole control measure is inadequate in any setting and is not cost-effective in resource-limited settings. Alternative or additional measures are clearly needed in hospitals with a high incidence of active TB admissions, specially following recent recommendations from the WHO, which

consider personal respiratory protection as the third line of defense for TB control, indicated when TB risk cannot be adequately reduced by administrative and engineering controls.

Tuberculin Screening

The benefit of tuberculin testing of workers is supported by data from cohort studies, controlled trials of isoniazid, and risk–benefit and cost–benefit analyses (42). In practice, however, the benefit is reduced because the institutions or personnel, particularly physicians, (43) may not comply with screening requirements, and less than 25 percent of people with positive reactions who are identified by screening complete at least six months of therapy. Studies have looked at the risk factors for a positive tuberculin skin test among employees of teaching hospitals;(44) in a study performed by Thomas C et al the possible risk factors that were identified include age (odds ratio of 2.2 per decade); black race(odds ratio 1.58), Asian race (odds ratio 16.7) and percentage of low income persons within the employees residential postal zone(odds ratio 1.39); Also in this study 52% of the tuberculin conversions occurred among employees with no direct contact with patients. In health care settings, when tuberculin testing is done on a periodic basis, some individuals will exhibit a "booster" phenomenon; ie, an anamnestic response will increase the induration elicited by 5 Units of PPD. Employers should perform two-step tuberculin testing of all newly hired HCWs who have not had tuberculin tests within the previous 12 months. This will avoid pseudoconversions, in which a booster effect can mimic an actual conversion from TB exposure later in their

employment. Booster phenomenon may confound the results of tuberculin skin testing. In developed countries the impact of boosting phenomenon on TST testing has been assessed. Baseline 2-step tuberculin skin testing (TST) is recommended for health care workers (HCWs) to identify cases of the "boosting phenomenon" (i.e., a negative initial TST result followed by a positive result) and to track the risk of acquiring occupational tuberculosis. However, the 2-step TST has been shown to be insufficient to identify all cases of the booster phenomenon in older adults and refugees. Kraut A et al performed a study to identify whether a history of bacille Calmette-Guerin (BCG) vaccination and foreign birth--variables that are known to be associated with the booster phenomenon--remain predictors of a positive TST result in a group of HCWs documented to have negative 2-step TST results (i.e., 2 TSTs done 7-28 days apart with indurations <10 mm in diameter). They performed a retrospective analysis of an employee database in a tertiary care hospital in Winnipeg, Canada. The study population was comprised of 698 HCWs with negative 2-step TST results who underwent a TST 0-2 years after completion of the 2-step procedure. Forty-six HCWs (6.6%) had a positive TST result 0-2 years after the 2-step test. In a multiple logistic regression analysis controlling for age, BCG vaccination, foreign birth, sex, and work setting, only history of BCG vaccination (odds ratio [OR], 8.38; 95% confidence interval [CI], 4.04-17.4), foreign birth (OR, 3.19; 95% CI, 1.53-6.62), and high-risk work setting (OR, 2.93; 95% CI, 1.44-5.95) were associated with a positive TST result. Even for HCWs with negative results of 2-step TST, foreign birth and history of BCG vaccination are associated

with a positive result of a future TST. Some positive TST results in such HCWs are related to nonoccupational factors, including delayed boosting, rather than to conversion due to recent tuberculosis contact.

The frequency of periodic PPD testing should be consistent with the results of risk assessments done in accord with CDC guidelines. Tan et al examined the utility of tuberculin skin testing in a developing country with a high prevalence of BCG vaccination. Tuberculin purified protein derivative RT-23 (State Serum Institute, Copenhagen, Denmark) was used for the TST (Mantoux). One hundred thirty-seven (52.1%) and sixty nine (26.2%) of the HCWs tested had indurations of 10 mm or greater and 15 mm or greater, respectively. Medical ward HCWs were at significantly higher risk of a positive TST reaction than were surgical or orthopedic ward HCWs (odds ratio, 2.18; 95% confidence interval, 1.33 to 3.57; P = 0.002 for TST positivity at 10 mm or greater) (odds ratio, 2.61; 95% confidence interval, 1.44 to 4.70; P = .002 for TST positivity at 15 mm or greater). A previous TST was a significant risk factor for a positive TST reaction at either 10 mm or greater or 15 mm or greater, but a duration of employment of more than 1 year and being a nurse were only significantly associated with a positive TST reaction at a cut-off point of 15 mm or greater. A TST cut-off point of 15 mm or greater may correlate better with M. tuberculosis infection than a cut-off point of 10 mm or greater in settings with a high prevalence of BCG vaccination.

Bacille Calmette–Guérin Vaccination

Given the high costs and poor compliance associated with tuberculin testing and treatment with isoniazid, Bacille Calmette–Guérin (BCG) vaccination may be a more cost-effective strategy, (43) particularly since such an approach would be equally effective for drug resistant strains. However, BCG vaccination has not been recommended, because the efficacy of the vaccine is variable, ranging from 0 to 80 percent in controlled trials, (45) and because when given to adults the vaccine makes subsequent reactions to tuberculin uninterpretable.

EFFICACY OF CONTROL MEASURES

A study on the efficacy of control measures in preventing nosocomial transmission of multidrug resistant tuberculosis to patients and health care workers, done by Susan A et al, revealed that implementation of the CDC 1990 guidelines for preventing transmission of tuberculosis including 1) prompt isolation and treatment of patients with tuberculosis; 2) rapid diagnostic techniques for processing mycobacterium tuberculosis specimens; 3) negative pressure isolation rooms and 4) molded surgical masks for health care workers decreased the tuberculin skin test conversion rates among HCWs assigned to wards housing patients with tuberculosis. The TST conversion rate decreased from 17% before the intervention to 5% post intervention (46). After control measures were introduced, health care workers with and without frequent direct patient contact had similar rates of tuberculin skin-test conversion. Henry et al in yet another study have evaluated the efficacy of expanded tuberculosis infection control measures consisting primarily of administrative controls (47). The new

expanded respiratory isolation policy included mandatory isolation of all patients with active tuberculosis, those with tuberculosis that was established in the differential diagnosis (or when an acid-fast bacilli sputum smear and culture were ordered), and those with HIV infection who had an abnormal chest radiograph. Isolation could be discontinued only after three consecutive negative acid-fast bacilli sputum smears were obtained or when the patient was discharged from the hospital. Additional administrative controls included increased surveillance by the Epidemiology/Infection Control Department to ensure that all patients with acid-fast bacilli sputum smear and culture specimens received by the clinical microbiology laboratory were in respiratory isolation and expanded health care worker education about tuberculosis. After expanded infection control measures were implemented, the number of tuberculosis exposure episodes decreased from 4.4 per month to 0.6 per month. A concomitant decrease in tuberculin skin test conversion rates in health care workers was seen; 6-month tuberculin skin test conversion rates decreased steadily from 3.3% to 0.4% ($P < 0.001$). The effectiveness of a TB infection-control program is measurable by ongoing monitoring of tuberculin conversions among HCWs, scrutiny of clusters of such conversions, investigation of possible person-to-person transmission, and similar analyses.

However for many HCWs, the community provides a greater risk of exposure to and infection with tuberculosis than does occupational exposure. A study by Bailey et al carried out at Barnes-Jewish Hospital in St. Louis, USA demonstrated in the setting of a "moderate risk" hospital with TB control

measures in place, socioeconomic status (using employee zip code as an indicator) was the primary risk factor for TST conversion rather than whether the employee had contact with patients. Skin-test conversion was independently associated only with the percentage of low-income persons in the employee's postal zone (44). This factor also has to be taken into consideration while evaluating the efficacy of TB control measures.

Whether similar results could be reproducible in hospitals in the developing world handling large numbers of tuberculosis patients needed to be investigated. Similar results have been demonstrated in developing countries like Thailand (48). A prospective study among health care workers was undertaken with annual tuberculin skin test screening and active TB surveillance. Following a comprehensive risk assessment, preventive interventions were implemented targeting HCWs, hospitalized patients, and the hospital environment. The number of pulmonary TB cases diagnosed increased steadily from 102 in 1990 to 356 in 1999. The TST conversion rate was 9.3 (95% CI 3.3-15) per 100 person-years in 1995-1997, but declined steadily to 2.2 (95% CI 0.0-5.1) in 1999. HCWs first screened within 12 months of employment had higher TST conversion rates (adjusted RR = 9.5, 95% CI 1.8-49.5) compared to those employed for longer than 12 months. The annual rate of active TB per 100 000 HCWs was 536 in 1995-1999. Implementation of nosocomial TB control measures in was followed by declining TST conversion rates, despite increasing exposure to active TB patients

In summary the current risk of tuberculosis among health care workers varies considerably among and within health facilities (49).Epidemiological studies are needed to identify the high risk subgroups among health care workers and to identify potential risk factors for transmission of disease .Such observations would lead to further implementation of cost effective infection control measures and analysis of the efficacy of such measures with respect to developing countries like India.

MATERIALS AND METHODS

RESEARCH PROTOCOL:

DESIGN

1. Prospective and retrospective descriptive cohort study design for determining the incidence of clinical tuberculosis disease among health care workers and to determine the clinical profile of tuberculosis disease among the target population.
2. Case control study design to determine the specific risk factors for acquiring tuberculosis in the target population. Prospectively (from April 2003- August 2004) and retrospectively (from January 1994- March 2003) collected cases will be used.

DURATION:

From April 2003 to August 2004, a sixteen month period.

LOCATION:

Departments of General Medicine units I, II and III, Staff Students Health Services.

SUBJECTS:

INCLUSION CRITERIA:

Health care workers employed at Christian medical college hospital, Vellore who are diagnosed to have tuberculosis.

EXCLUSION CRITERIA:

i Patients who were diagnosed to have active tuberculosis or have received treatment for tuberculosis prior to joining the health care facility.

ii. Patients diagnosed to have tuberculosis during the pre employment screening.

iii. Patients who are having a relapse of tuberculosis during the study period and if the index episode is prior to January 1994.

SCOPE AND NEED FOR THE STUDY:

As mentioned in the above mentioned discussion there is urgent need in developing countries to identify the high-risk subgroups among HCW and to identify potential risk factors for nosocomial transmission of tuberculosis. Also identifying factors associated with a delay in making the diagnosis of tuberculosis among health care workers would lead to early diagnosis and prompt treatment of this disease, thereby reducing the nosocomial transmission of tuberculosis both to other patients and health care workers. This would in turn provide the basis for further research on cost effective infection control measures with special reference to the needs of developing countries.

RESEARCH METHODOLOGY:

Patients having active tuberculosis disease among the health care workers working in this institution were enlisted in the study.

CASE DEFENITION:

A **health care worker** is defined as any person registered as a staff member in the hospital either on a permanent or temporary basis for more than 6 months.

A **case** is defined as any health care worker diagnosed to have active tuberculosis, with symptoms and/or signs attributable to the disease. The

diagnosis may be on the basis of clinical and at least one of the following criteria: microbiological (acid fast bacilli smear positive, mycobacterium culture positive) / histopathological (biopsy with granulomatous inflammation or showing acid fast bacilli on tissue staining) / radiological (chest X-ray, CT-scan etc) evidence of the disease.

CONTROLS:

The following control group was selected: Random selection of health workers who are free of tuberculosis disease to assess the risk factors for acquiring tuberculosis among HCW.

To select this cohort of controls initially a master-list of all the employees in the hospital was generated, ordered alphabetically. From this list unmatched controls was chosen by random sampling. All the members of the control group were subjected to a clinical examination. Exclusion criteria for this group of controls included presence of active tuberculosis in the past.

DATA COLLECTION:

Baseline data pertaining to disease load in the hospital was collected. This includes:

a. the annual number of inpatients with tuberculosis
b. the distribution of sputum positive and negative cases

The following data was collected from the cases and the hospital controls:

- The demographic characteristics: including age, sex.
- Educational qualifications
- Diagnosis

- Occupational subgroup. All the different job descriptions are classified as groups with frequent, limited or no direct contact with patients.

Frequent contact: health care workers involved in regular clinical care of patients. Employees who had direct contact with patients include physicians, nurses, nursing technicians and respiratory therapists.

Limited contact: health care workers who are not involved in day-to-day clinical care of patients but interact with patients and their relatives for a limited period of time during their work schedule. Those with limited contact include medical records personnel, unit clerks, and dietitians, cleaning staff, attendants, enquiry office workers, phlebotomists, social workers and transporters.

No direct contact: this group includes health care workers in the laboratory and administrative services, who have no direct patient interaction. Those with no direct contact include accountants, administrators, cashiers, laboratory personnel, laundry workers and pharmacists.

- Main area of employment in the previous one year.

Area of employment is defined as the ward or location where the health care worker was posted during the majority of months in the previous year.

- Department.

The department where the health care worker was posted during the previous one year.

- Presence of BCG vaccination.

The presence of BCG vaccination was documented by identifying the vaccine scar on the shoulder of the subject.

- Income.
- Duration of employment in the hospital.

Duration of service was defined as the time interval from the date of joining the institution to the date of acquiring tuberculosis.

- Body mass index.

BMI was calculated using the formula Weight in Kg/ Height in meters^2. In order to assess the baseline body mass index prior to acquiring tuberculosis, the weight documented during the previous year visit was taken for the cases.

- Number of days of work lost due to this illness
- Co morbid conditions including diabetes mellitus and COPD
- Immunosuppressive therapy.
- History of non-occupational exposure to tuberculosis during the previous six months
- History of family contacts with tuberculosis
- Clinical features including presenting complaints, duration of complaints etc
- Laboratory data including microbiology reports, histopathology reports and other relevant lab data will be collected.

CONFIDENTIALITY ISSUES:

The identity of the patients was protected. Each subject was assigned a code number, which was available in databases and in hard copies of the formats. Name and identification were only available in the code register, which was protected and accessed by the investigators only.

CONSENT:

Informed written consent was taken from all individuals before enrollment and they were allowed any opt out of the study at any time if they wish to do so. The consent form is attached.

ANALYSIS:

At the end of the study, the incidence of tuberculosis among the health care workers, the risk factors for developing tuberculosis and the factors associated with a delay in diagnosis of tuberculosis were described. Chi square test and student t test will be used to determine the significance of clinical associations studied. Logistic regression analysis will be used to determine independent risk factors for developing tuberculosis.

SAMPLE SIZE:

For *Sample size* calculation similar data from other studies including studies cited in reference numbered 15, 16 and 44 were utilized. The proportions derived from these studies were used to calculate the sample size for the case – control study looking at the clinical associations using the formula:

$$\mathbf{n = \frac{(2Z^2pq)}{d2}}$$

where

n = sample size

Z is a constant (for a 95% confidence interval, Z is 1.96)

P = $(p_1+p_2)/2$, where p_1 is the rate in the exposed group and p_2 is the rate in the unexposed group

q = 1-p

d = p_1-p_2

Since the largest number among the individual Sample sizes was 123, we planned to study 125 patients for the study. Another 125 in-hospital controls were planned to be selected.

RESULTS

The results of the study are summarized here. The results will be presented in three sections. The first section depicts data regarding the clinical profile of health care workers who developed tuberculosis. The second section deals with the associations of a more than median delay in the diagnosis of tuberculosis (case-control study).The third section is a case control study designed to identify the risk factors for developing tuberculosis among the health care workers.

Section I:

CLINICAL PROFILE OF PATIENTS WITH TUBERCULOSIS

BASIC DEMOGRAPHIC DETAILS:

During the period from January 1995 to August 2004, 141 health care workers developed tuberculosis. Prospective data was collected from April 2003 to August 2004. All patients were interviewed and the medical records [Out-patient chart and In-patient record] were reviewed. Among these 141 patients only 101 were still continuing to serve in the health facility. 40 patients could not be contacted as they had left the institution. These 101 patients were included in the final survey.

AGE

The patients were all adults more than 21 years of age. The age range extended from 21 to 60 years. The mean age of the patients was 34 years. The

mode was same as the mean age and the median age was 32 years. The range is 44 years and the standard deviation is 9.79 years giving a wide range of distribution. Table 1.1.01 gives the age distribution and the measures of variability.

age distribution of cases table 1.1.01

AGE	
Mean	34.0000
Median	32.0000
Mode	34.00
Std. Deviation	9.79000
Range	44.00
Minimum	21.00
Maximum	60.00

SEX

Among the total 101 cases, 43 (42.6%) were men and 58 (57.4%) were women. Figure 1.1.02 depicts the sex distribution among the cases.

TIME DISTRIBUTION OF CASES

The highest incidence of cases was found in the years 2002 and 2003. The number of cases reported were 16 (15.8%) and 17(16.8%) respectively in these two years. Similar trends were observed in the years 1998 (15 cases) and 2001(14 cases). Fewer numbers of patients belonging to the 1995-1997 time interval were enrolled, the reasons for this have been discussed in the discussion section below.

Histogram depicting the distribution of cases over time is provided [figure 1.1.03].

INCIDENCE OF TUBERCULOSIS

All the patients who were reported to have tuberculosis in the time interval 2001-2003 could be enrolled in the study. The incidence rates have been calculated for these years [table 1.1.02]. The maximum incidence for tuberculosis disease was found in the year 2003 [314 cases per 1, 00,000 person years]. There is an increase in the incidence of tuberculosis over the years from 2001 to 2003 as also depicted in the figure 1.1.03.

The number of health care workers employed in the institution has also been increasing over the years. In 2004-2005 the number of health care workers employed stand at 6005.

Table 1.1.02

Year of diagnosis of tuberculosis	Number of cases	Number of HCWs	Incidence of tuberculosis cases per 1,00,000 person- years
2001	14	4873	287.29
2002	16	5388	296.19
2003	17	5402	314.68

Table1.1.03 Incidence rates for year 2003

Diagnosis	Number of **cases**	Number of **HCWs**	**Incidence** per 100,000 person years	Percentage %
sputum positive pulmonary TB	6	5402	111.06	35.29
sputum negative pulmonary TB	3	5402	55.53	17.64
tuberculous lymphadenitis	2	5402	37.02	11.76
spine/bone/joint TB	1	5402	18.11	5.88
abdominal tuberculosis	1	5402	18.11	5.88
Genitourinary tuberculosis	2	5402	37.02	11.76
Other extra-pulmonary /disseminated TB	2	5402	37.02	11.76

Incidence rate for the different subtypes of tuberculosis for the year 2003 are provided in table 1.2.02. The incidence of sputum positive pulmonary tuberculosis was 111.06 per 100,000 person years. Extra-pulmonary tuberculosis accounted for 47% of the cases and pulmonary tuberculosis accounted for 53%. Among the extra-pulmonary cases the main sub-types were tuberculous lymphadenitis and genitourinary tuberculosis.

EDUCATIONAL QUALIFICATION OF CASES

Table 1.1.04 depicts the educational qualification of the cases. The majority (46.5%) had done a diploma course. This included diploma in nursing and a variety of other allied health sciences like medical laboratory technology course, critical care and respiratory medicine certificate course, anesthesia

technician training course, medical records technology course, radio-diagnosis technology course, dental assistance course etc. 25 cases (24.8%) were graduates and 13 cases (12.9%) were post-graduates. The graduate category included the medical, physiotherapy, nursing, and medical laboratory technology graduates. The post graduates were mostly doctors and other technical and research staff. 16 cases (15.9%) had attained only higher secondary or lower level of education. This group predominantly consisted of the unskilled labour force and included the attendants and cleaning staff and manual labourers.

educational qualification of cases table 1.1.04

	Frequency	Percent
illiterate	1	1.0
primary school	7	6.9
secondary school	5	5.0
higher secondary	3	3.0
diploma/certificate course	47	46.5
graduate degree	25	24.8
postgraduate degree	13	12.9
Total	101	100.0

OCCUPATIONAL SUBGROUP WISE DISTRIBUTION OF CASES

The occupation wise distribution of cases is provided in table 1.1.05. Nurses formed the largest subgroup with 41 cases (40.6%) followed by doctors constituting 21 cases (20.8%). Attendants and cleaning staff though constituting a significant proportion of the personnel population (19.54%) contributed to form only 12.9% of the cases (13 cases). There were only six cases (5.9%) among the administrative services category in spite of them constituting 11.36% of the personnel population in 2003.

occupational subgroup table 1.1.05

	Frequency	Percent	Total composition of HCW (%)
administrative services	6	5.9	11.4
attenders and cleaning staff	13	12.9	19.5
doctors	21	20.8	11.9
engineering services	1	1.0	6.4
nurses	41	40.6	29.2
social workers	2	2.0	.5
technical staff	14	13.9	16.4
laboratory staff	3	3.0	4.6
Total	101	100.0	100.0

OCCUPATIONAL PATIENT CONTACT WISE DISTRIBUTION OF CASES

The distribution of tuberculosis cases among the health care workers according to the occupation related patient exposure is provided in table 1.1.06.

distribution of cases according to contact with patients table 1.1.06

CONTACT WITH PATIENTS	Frequency	Percent
frequent contact	65	64.4
infrequent contact	20	19.8
no direct contact	16	15.8
Total	101	100.0

Majority had direct patient contact (64.4%) and 15.8% of the cases had no direct patient contact. The occupational categories including administrative services and engineering services and few of the attendants and cleaning staff had no direct patient contact. Also laboratory technical workers and doctors working in labs were classified having no direct contact. Figure 1.1.06 depicts the distribution.

WORK EXPERIENCE AT THE INSTITUTION

The mean work experience of the cases at the health facility prior to acquiring the disease was 7.38 years. The range extended from a minimum of 3 months to a maximum of 37 years and 9 months. The mode was 2.78 years and the median work experience prior to acquiring disease was 4.55 years. The work experience distribution curve is positively skewed. The range is 37.55 years and the standard deviation is 7.64 years giving a wide range of distribution. The distribution of the cases by work experience is depicted in figure 1.1.07. Table 1.1.07 gives the work experience distribution and the measures of variability.

table 1.1.07

experience at facility in years	
Mean	7.3800
Median	4.5500
Mode	2.78
Std. Deviation	7.64000
Variance	58.47000
Range	37.55
Minimum	.20
Maximum	37.75

NON-OCCUPATIONAL EXPOSURE TO TUBERCULOSIS

In four cases there was non occupational contact with cases of pulmonary tuberculosis in the one year prior to developing disease. In two cases the contacts were first degree family members. The other two had room mates who had pulmonary tuberculosis being the contacts.

FAMILY CONTACTS HAVING TUBERCULOSIS

There was family history of pulmonary tuberculosis in four cases. Of these only in two cases the exposure occurred in the one year prior to developing disease. All exposures were sustained from first degree relatives.

RESIDENCE WISE DISTRIBUTION OF CASES

The majority of health care workers who developed tuberculosis were residing off both the hospital and college campuses. This group predominantly was comprised of the technical and laboratory staff, attendants and cleaning staff. About 6% of the cases were residing in the hospital campus itself. This group included mainly nursing staff, medical residents and interns.

AREA OF EMPLOYMENT IN THE PREVIOUS ONE YEAR

Table 1.1.08 depicts the distribution of cases according to the area of employment, in the year prior to developing tuberculosis. The maximum number of cases were employed in the medical wards, 19 cases (18.8%).This was followed by microbiology which accounted for 7 cases (6.9%). There were five cases (5%) that were reported from the radiology department. Medical records department and operation theatre complex accounted for four cases (4%) each. Locations which handle large volumes of tuberculosis patients and other patients with chronic cough like the pulmonary functions lab, tuberculosis isolation wards and the medical ICU accounted for only one patient each (1%). Figure 1.1.10 depicts a graphic representation of the distribution.

area of employment in the past 1 year
table 1.1.08

		Frequency	Percentage
Valid	A K LAB	3	3.0
	ACCOUNTS	1	1.0
	ALC	1	1.0
	BIOSTATISTICS	1	1.0
	BLOOD BANK	1	1.0
	CARDIOLOGY	1	1.0
	CEU	1	1.0
	CSSD	2	2.0
	DIETARY	2	2.0
	DIRECTORATE	1	1.0
	ELECTRICAL	1	1.0
	EMERGENCY SERVICES	2	2.0
	ENDOSCOPY RROM	1	1.0
	HLRS OFFICE	1	1.0
	I WARD	2	2.0
	ISOLATION WARD	1	1.0
	K N WARD	1	1.0
	L WARD/HEMATOLOGY	1	1.0
	MATERNITY WARDS	3	3.0
	MEDICAL RECORDS	4	4.0
	MEDICAL WARDS	19	18.8
	MICROBIOLOGY	7	6.9
	MICU	1	1.0
	N 2 WARD	2	2.0
	NEURO ICU	1	1.0
	OPERATING ROOMS	4	4.0
	ORTHO OPD	1	1.0
	P 2 WARD	2	2.0
	PAEDIATRIC WARD	3	3.0
	PFT LAB	1	1.0
	PHARMACY	3	3.0
	Q1 WEST	2	2.0
	R WARD	3	3.0
	RADIOLOGY	5	5.0
	S WARD	3	3.0
	STAFF CLINIC	1	1.0
	Total	101	100.0

BCG VACCINATION STATUS OF CASES

The majority of the health care workers who developed tuberculosis had been vaccinated. Only 17 cases (16.8%) had not been vaccinated. Table 1.1.09 depicts the vaccination status.

BCG vaccination status of cases table 1.1.09

	Frequency	Percent
vaccinated	84	83.2
not vaccinated	17	16.8
Total	101	100.0

DEPARTMENT WISE DISTRIBUTION OF CASES

The department wise distribution of cases is depicted in table 1.1.10. The nursing service was the department that accounted for the maximum number of cases. There were 42 cases (41.6%) reported from the nursing services department. Microbiology accounted for 7 cases (6.9%). Six cases were reported from the general medicine department (5.9%). There was equal number of cases reported from the personnel department (5.9%). This group was comprised of attendants and cleaning staff employed in various wards and supervised by the personnel department. There were five cases (5%) reported from the radiology department. This group mainly included X-ray technicians. There was only one case reported from the pulmonary medicine unit during this time period. Administrative services and accounts department reported very low number of cases during the study period. Figure 1.1.09 provides a graphic representation of the department wise distribution of cases.

department wise distribution of cases table 1.1.10

	Frequency	Percent
ACCOUNTS	1	1.0
ALC	1	1.0
BIOSTATISTICS	1	1.0
CARDIOLOGY	1	1.0
CEU	1	1.0
CLINICAL PATHOLOGY	1	1.0
CSSD	1	1.0
DIETARY	2	2.0
DIRECTORATE	1	1.0
ELECTRICAL	1	1.0
EMERGENCY SERVICES	1	1.0
ENGINEERING	1	1.0
GENERAL SURGERY	1	1.0
HLRS	1	1.0
MEDICAL RECORDS	4	4.0
MEDICINE	6	5.9
MICROBIOLOGY	7	6.9
NEPHROLOGY	1	1.0
NURSING SERVICES	42	41.6
OBSTRETICS	1	1.0
ORTHOPAEDICS	3	3.0
PAEDIATRICS	1	1.0
PERSONNEL OFFICE	6	5.9
PHARMACY	3	3.0
PSYCHIATRY	1	1.0
PULMONARY MEDINCINE	1	1.0
RADIOLOGY	5	5.0
RADIOTHERAPY	2	2.0
Total	101	100.0

BODY MASS INDEX

The mean body mass index was 20.44 Kg/m^2. The median value was 20.07 Kg/m^2. The BMI range extended from 12.33 to 34.60 Kg/m^2. The mode was less than the mean BMI. The range is 22.7 and the standard deviation is 3.95 Kg/m^2. The distribution of the cases by BMI values is table 1.1.11.

body mass index Kg/m2 table 1.1.11

body mass index Kg/m2	
Mean	20.4400
Median	20.0700
Mode	17.33
Std. Deviation	3.95000
Variance	15.62000
Range	22.27
Minimum	12.33
Maximum	34.60

CO-MORBID ILLNESSES

Table 1.1.12 depicts the co-morbid illnesses. Hypertension was the most common co-morbidity accounting for nine cases (8.9%). This was followed by diabetes mellitus type 2 in six cases (5.9%). Collagen vascular diseases were present in 2%. Only two patients were on long term immunosuppressive therapy prior to acquiring tuberculosis. Both these were SLE patients.

co-morbid conditions table 1.1.12

	Frequency	Percent
none	79	78.2
diabetes mellitus	6	5.9
hypertension	9	8.9
COPD	2	2.0
collagen vascular diseases	2	2.0
others	3	3.0
Total	101	100.0

SMOKING STATUS OF CASES

Among the cases 12.09% were current smokers and 2% were ex-smokers at the time of acquiring tuberculosis. Among the 38 cases of sputum positive pulmonary tuberculosis five were current smokers.

EXPOSURE TO HIGH RISK PROCEDURES

38% of the cases were exposed to high risk or potentially infectious cough inducing procedures. This includes procedures like bronchoscopy, intubation, ryles tube insertion, nebulisation, induced sputum production etc. Of the people who were exposed to high risk procedures 62.12% (23 cases) routinely used respiratory protective equipment/ masks. 1% cases were unable to recall if they used respiratory protection routinely. Table 1.1.17 depicts the exposure of cases to high risk procedures and the use of respiratory protection during these procedures.

Cases: use of respiratory protection during high risk procedure table 1.1.13

	Frequency	Percent
yes	23	22.8
no resp protection used	14	13.9
unable to recall	1	1.0
not applicable	63	62.4
Total	101	100.0

KNOWLEDGE REGARDING TUBERCULOSIS

86 cases (85.1%) had adequate knowledge about the modes of transmission of tuberculosis. 84 cases (83.2%) had adequate knowledge regarding the use of respiratory protection in the transmission of tuberculosis.

DIAGNOSIS OF TUBERCULOSIS

ANATOMICAL DIAGNOSIS

Figure 1.1.10 depicts the subtypes of tuberculosis. The main subtype of tuberculosis was sputum positive pulmonary. There were 38 cases (37.6%) in this category. 23.8% cases were sputum negative pulmonary tuberculosis. 38%

were extra-pulmonary cases. 43.5% of extra-pulmonary tuberculosis cases were that of tuberculous lymphadenitis. Bone and joint tuberculosis and genitourinary tuberculosis constituted 5% each of the total number of cases. The overall proportion of sputum positive pulmonary tuberculosis was similar in the 2003-2004 time interval when data was collected prospectively and in the 1994-2003 time period when data was collected retrospectively (35.29% in 2003-2004 vs 37.6% overall 1994-2004). Of the 24 cases of smear negative pulmonary tuberculosis, 19 cases had pleural effusion (79.16%). Figure 1.1.10 depicts the distribution of the various subtypes of tuberculosis.

tuberculosis subtypes **table1.1.14**

	Frequency	Percentage
sputum positive pulmonary TB	38	37.6
sputum negative pulmonary TB	24	23.8
tuberculous meningitis	3	3.0
tuberculous lymphadenitis	17	16.8
spine/bone/joint TB	5	5.0
abdominal tuberculosis	3	3.0
genitourinary tuberculosis	5	5.0
other extrapulmonary/ disseminated TB	6	5.9
Total	101	100.0

SYMPTOMS AT PRESENTATION

The most common presenting complaint was fever which was present in 61.4% of the patients. This was followed by cough which was present in 43.6% of patients. Weight loss was a marked symptom in many of the patients (21.8%). Headache, vomiting and altered sensorium was present in more than 10% of the cases, though not all were demonstrated to have altered sensorium.

Table 1.1.15 depicts the distribution of the presenting symptoms across the patient population.

Table 1.1.15

Presenting symptoms	Number of cases	Percentage
Fever	62	61.4%
Cough	44	43.6%
Weight loss	22	21.8%
Hemoptysis	4	4%
Lymph node enlargement	14	13.9%
CNS manifestations	12	11.9%

LABORATORY PARAMETERS

The mean erythrocyte sedimentation rate (ESR) at presentation was 50mm at one hour. The mode was 45 mm at one hour and was same as the median value. The number of patients with anemia of chronic disease was very few, with the mean and the median hemoglobin value being about 12.4 gm%. The mean leukocyte count was 8392 cells/mm^3 and the standard deviation being 3489 cells/mm^3

The mean absolute lymphocyte count was 8392 cells/mm^3. There were no patients with renal failure in this group of patients. Table 1.1.21 depicts the distribution of the various lab parameters.

lab parameters: cases **table 1.1.16**

	hemoglobin grams%	ESR at one hour mm	total WBC count cells/cu.mm	absolute lymphocyte count cells/cu.mm	creatinine mg%
Mean	12.5000	50.03	8392.89	1936.14	.8785
Median	12.4000	45.00	7800.00	1728.00	.9000
Mode	12.70	45	7600	1216	.90
Std. Deviation	2.51000	33.000	3489.000	1051.000	.18833
Range	22.10	118	27400	5890	.90
Minimum	7.90	2	1600	114	.60
Maximum	30.00	120	29000	6004	1.50

Tuberculin skin testing was performed in 27.7% of the patient population. Of the patients who underwent a tuberculin skin testing 71.4% yielded a positive result. Skin testing was not used to aid in the diagnostic process in a majority of patients. Chest X-ray was abnormal in a majority of patients (in 65.3% of the cases). This was in spite of the fact that only 43.6% of the patients had cough as a presenting complaint. A majority of cases with disseminated tuberculosis had positive chest X-ray findings. The common chest X-ray findings included pleural effusion, consolidation, fibro-cavitatory tuberculosis in the descending order of frequency.

Sputum AFB smear was performed in 68.3% of the patients; of these 55.9% were sputum AFB smear positive. Mycobacterial cultures were performed in 82.2% of the cases. The major source of specimen was sputum (42.6%), this was followed by pleural biopsy cultures (11.9%), lymph node biopsy cultures (8.9%), and CSF cultures. Culture growth was present in 44.6% of the cases. Biopsy for obtaining histopathology was performed in 47.5% of the cases. 42.6% cases revealed granulomatous inflammation consistent with a diagnosis of

tuberculosis no histopathology. Table 1.1.17 shows the culture results. Table 1.1.18 depicts the sources of the specimen obtained.

mycobacterial culture result **table 1.1.17**

		Frequency	Percent
	mycobacterium isolated	45	44.6
	no growth	37	36.5
	culture not done	18	17.8
	Total	100	99.0
Missing		1	1.0
Total		101	100.0

Mycobacterial cultures: source of specimens **table 1.1.18**

		Frequency	Percent
	sputum	43	42.6
	CSF	4	4.0
	pleural fluid	12	11.9
	lymph node	9	8.9
	others	14	13.9
	culture not done	18	17.8
	Total	100	99.0
Missing		1	1.0
Total		101	100.0

Of the 19 cases of pleural effusion, 11 cases had pleural biopsy showing granulomatous inflammation consistent with tuberculosis, 3 had pleural fluid culture growing *mycobacterium tuberculosis*, 1 had pleural biopsy tissue growing *mycobacterium tuberculosis*.

CULTURE SENSITIVITY

There were 3 patients with multidrug resistant tuberculosis according to culture sensitivity reports. Of these one patient was employed in the microbiology

department as an attendant, another patient was a respiratory medicine technician and yet another was a nursing staff. In one patient working as an attendant in the pharmacy the sputum culture grew a strain that was INH resistant.

Section II

DELAY IN THE DIAGNOSIS OF CASES

The duration from the onset of symptoms to diagnosis was documented. This includes the patient delay which is the time from the onset of symptoms to the presentation to the clinic and the physician delay, which is the time from patient presenting to the health facility to the time of making the diagnosis. The mean delay in diagnosis was 37.98 days. The standard deviation was 38.6 days. And the minimum delay was 2 days and the maximum was 180 days. Table 1.2.18 depicts the distribution of cases. Figure 1.1.12 shows the distribution of cases according to the delay in diagnosis.

delay in diagnosis of cases (days) table 1.2.19

duration of onset of symptoms to diagnosis	
Mean	37.90
Median	21.00
Mode	7
Std. Deviation	38.670
Range	178
Minimum	2
Maximum	180

Delay in diagnosis of tuberculosis was associated with increased morbidity. The mean number of work days last was significantly higher in the group with more than mean duration of delay in diagnosis of tuberculosis. In the

group with more than mean delay in diagnosis of tuberculosis, the work days lost was 16.9 days compared to 12.6 days in the group with less than or equal to mean delay in diagnosis of tuberculosis (p-value=0.025).

delay in diagnosis of tuberculosis subtypes (days)
table 1.2.20

	number	days
bone tuberculosis	5	47.20
smear negative pulmonary tuberculosis	24	20.08
smear positive tuberculosis	38	40.24
extra-pulmonary tuberculosis	39	46.79

CASE CONTROL STUDY: RISK FACTORS ASSOCIATED WITH A MORE THAN MEAN DELAY IN THE DIAGNOSIS OF TUBERCULOSIS AMONG HCWs.

All the below mentioned variables were included in the analysis for risk factors associated with a more than mean delay in the diagnosis of tuberculosis.

INDIVIDUAL FACTORS

For categorical variables, using Chi-square test and Fisher's exact test wherever applicable, the significant individual risk factors for mortality were identified.

The Cochran's and Mantel Haenszel statistics (odds ratio) for the categorical dichotomous variables was also calculated. Also the 95% confidence intervals of the odds ratio are displayed. In this analysis, whenever the variables were not dichotomous or when one of the variable column had value of zero, the

Cochran's and Mantel Haenszel statistic was not calculated. For continuous variables, Independent samples T test was done to determine significant risk factors for mortality. Only summary statistics of the variable analysis is displayed here. The variables in bold italics are the significant risk factors for delay in diagnosis of tuberculosis.The factors which were associated with more than mean delay in diagnosis of tuberculosis among health care workers included: less than/ equal to 4 years duration of service at the institution [Odds ratio_2.226, p-value=0.05]. Sputum negative pulmonary tuberculosis was associated with a less than mean delay in diagnosis [Odds ratio_0.36, p-value=0.046]. Tuberculous pleural effusion accounted for a majority of these cases.

Table 1.2.21. Factors associated with more than mean delay in diagnosis of tuberculosis- CATEGORICAL VARIABLES (Chi square or Fisher's exact test)

VARIABLES ANALYSED	**p VALUE**	**ODDS RATIO**	**95% C.I. OF ODDS RATIO**
GENERAL CHARACTERSITICS			
Sex (Male)	0.080	0.483	0.213-1.096
EDUCATIONAL QUALIFICATION			

VARIABLES ANALYSED	p VALUE	ODDS RATIO	95% C.I. OF ODDS RATIO
Graduate degree or postgraduate	0.625	1.227	0.541-2.781
BCG VACCINATION			
BCG vaccinated	0.343	0.604	0.212-1.723
OCCUPATIONAL SUBGROUP			
Administative services personnel	0.186	0.252	0.028-2.24
Attendants and cleaning staff	0.356	0.558	0.16-1.95
Technical staff	0.235	1.981	0.632-6.206
Doctors	0.599	1.295	0.493-3.39
Nursing staff	0.852	0.926	0.414-2.07
Laboratory staff	0.392	2.780	0.244-31.70
OCCUPATIONAL CONTACT WITH PATIENTS			
Frequent contact with patients present	0.162	1.824	0.782-4.253
IMMUNOSUPPRESSIVE THERAPY PRESENT	0.177		
CO-MORBID CONDITIONS			
Diabetes mellitus type 2	0.759	1.366	0.185-10.10
Connective tissue disorders	0.097		

VARIABLES ANALYSED	**p VALUE**	**ODDS RATIO**	**95% C.I. OF ODDS RATIO**
BODY MASS INDEX<19 Kg/m^2	0.314	0.659	0.292-1.487
DURATION OF SERVICE (in years)			
< 4 years	**0.050**	**2.226**	**0.994-4.981**
4 to < 8 years	0.388	0.673	0.274-1.656
8 to < 12 years	0.557	0.65	0.153-2.76
> 16 years	0.318	0.562	0.180-1.758
SUBTYPE OF TUBERCULOSIS			
Extra-pulmonary tuberculosis	0.322	1.504	0.669-3.38
Sputum positive pulmonary tuberculosis	0.449	1.368	0.607-3.083
Sputum negative pulmonary tuberculosis	**0.046**	**0.36**	**0.129-1.006**
Bone tuberculosis	0.419	2.100	0.335-13.15
SYMPTOMS			
Fever absent	0.16	1.785	0.792-4.021
Cough absent	0.267	1.575	0.704-3.522
Hemoptysis absent	0.181	0.234	0.023-2.331

VARIABLES ANALYSED	p VALUE	ODDS RATIO	95% C.I. OF ODDS RATIO
Lymphadenopathy absent	0.576	1.396	0.432-4.50
CNS symptoms absent	0.946	1.043	0.307-3.541
OTHERS			
Normal chest X-ray	0.375	1.453	0.636-3.321
BCG vaccinated	0.343	0.604	0.212-1.723
Tuberculin skin test negative	0.403	2.037	0.379-10.93
Sputum smear negativity	0.411	0.667	0.253-1.756
Current smoker	0.356	0.558	

Table 1.2.22. Association between delay in the diagnosis of tuberculosis and the number of days of work lost.

VARIABLES ANALYSED	Delay >mean	Delay </= mean	p-value
Number of days of work lost	**16.9**	**12.67**	**0.025**

Table 1.2.23. Factors associated with more than mean delay in diagnosis of tuberculosis - continuous variables (Independent samples T test)

VARIABLES ANALYSED	Delay > mean	Delay </= mean	p-value
Age (in years)	32.09	35.43	0.09
Body mass index (Kg/m^2)	20.88	20.12	0.347
Duration of service in years	6.17	8.28	0.173
LAB PARAMETERS			
ESR (mm at one hour)	52.34	48.25	0.554
WBC counts (cells/ cu.mm)	7789	8853	0.138

Section III

CASE CONTROL STUDY FOR IDENTIFYING THE RISK FACTORS FOR TUBERCULOSIS AMONG HEALTH CARE WORKERS

All the below mentioned variables were included in the analysis for identifying the risk factors for tuberculosis among health care workers.

INDIVIDUAL FACTORS

For categorical variables, using Chi-square test and Fisher's exact test wherever applicable, the significant individual risk factors for mortality were identified.

The Cochran's and Mantel Haenszel statistics (odds ratio) for the categorical dichotomous variables was also calculated. Also the 95% confidence intervals of the odds ratio are displayed. In this analysis, whenever the variables were not dichotomous or when one of the variable column had value of zero, the Cochran's and Mantel Haenszel statistic was not calculated. For continuous variables, Independent samples T test was done to determine significant risk factors for mortality. Only summary statistics of the variable analysis is displayed here. The individual tables will be made available in the annexure section. The variables in bold italics are the significant risk factors associated with tuberculosis among health care workers.

On univariate analysis the factors that were associated with an increased risk of acquiring tuberculosis included, being employed mainly in the medical wards in the previous one year [Odds Ratio (OR)_5.618, 95% Confidence Interval (CI)_ 1.838-17.17], being in the initial four years of employment [OR_1.99, 95% CI_1.114-3.57], having frequent occupation related contact with patients [OR_2.339, 95% CI_1.328-4.120], having a body mass index <19 Kg/m^2 [OR_2.603, 95% CI_1.395-4.855] and residing in the hospital campus [OR_2.885, 95% CI_1.561-5.332].

Table 1.3.24. Risk factors associated with tuberculosis among HCWs - CATEGORICAL VARIABLES (Chi square or Fisher's exact test)

VARIABLES ANALYSED	p VALUE	ODDS RATIO	95% C.I. OF ODDS RATIO
GENERAL CHARACTERSITICS			
Sex (Male)	0.480	0.891	0.47-1.426
EDUCATIONAL QUALIFICATION			
Less than higher secondary level	0.248	0.638	0.296-1.373
Less than graduate degree	0.461	0.865	0.451-1.435
Graduate degree or postgraduate	0.461	1.243	0.697-2.21
BCG VACCINATION			
BCG vaccinated	0.316	0.666	0.300-1.478
OCCUPATIONAL SUBGROUP			
Administative services personnel	**0.024**	**0.336**	**0.126-0.867**
Attendants and cleaning staff	0.094	0.530	0.251-1.123
Technical staff	0.175	1.871	0.748-4.67
Doctors	0.132	1.77	0.835-3.78
Nursing staff	0.105	1.617	0.903-2.89
AREA OF EMPLOYMENT IN THE PREVIOUS ONE YEAR			
Medical wards	**0.001**	**5.619**	**1.838-17.180**
Microbiology	0.030	7.447	0.899-61.67
Radiology	0.471	1.701	0.369-7.31
Medical records	1.00	1.00	0.243-4.113

VARIABLES ANALYSED	**p VALUE**	**ODDS RATIO**	**95% C.I. OF ODDS RATIO**
OCCUPATIONAL CONTACT WITH PATIENTS			
Frequent contact with patients present	**0.003**	**2.339**	**1.328-4.120**
DEPARTMENT OF EMPLOYMENT			
Microbiology	**0.030**	**7.447**	**0.899-61.677**
Medicine	0.054	6.316	0.746-53.442
Personnel office	0.205	0.517	0.183-1.456
Radiology	0.248	2.578	0.488-13.609
Emergency services	0.174	0.243	0.027-2.208
Nursing services	0.78	1.685	0.941-3.015
RESIDENCE			
Hospital campus	**0.001**	**2.886**	**1.561-5.333**
College campus	0.174	4.125	0.453-37.55
Off both campuses	**<0.001**	**0.313**	**0.171-0.574**
IMMUNOSUPPRESSIVE THERAPY PRESENT	0.155		
CO-MORBID CONDITIONS			
Diabetes mellitus type 2	0.407	2.041	0.365-11.40
Connective tissue disorders	1.00	1.00	0.138-7.24

VARIABLES ANALYSED	p VALUE	ODDS RATIO	95% C.I. OF ODDS RATIO
EXPOSURE TO HIGH RISK PROCEDURES			
Exposed to high risk procedures	0.098	1.653	0.910-3.003
RESPIRATORY PROTECTION DURING HIGH RISK PROCEDURES			
Lack of respiratory protection during procedures	0.059	2.548	0.938-6.923
KNOWLEDGE ON USE OF RESPIRATORY PROTECTION			
Adequate knowledge	0.289	1.457	0.725-2.930
KNOWLEDGE ON MODES OF TRANSMISSION OF TUBERCULOSIS			
Adequate knowledge	0.452	1.328	0.633-2.788
FAMILY CONTACT WITH TUBERCULOSIS			
Family contact with TB present	0.517	0.653	0.179-2.387
BODY MASS INDEX<19 Kg/m^2	**0.002**	**2.603**	**1.396-4.856**
DURATION OF SERVICE (in years)			
< 4 years	**0.019**	**1.995**	**1.114-3.574**
4 to < 8 years	0.418	1.301	0.688-2.46
8 to < 12 years	0.366	0.662	0.27-1.627
12 to < 16 years	**0.010**	**0.165**	**0.036-0.766**

Table 1.3.25. Risk factors for tuberculosis among HCWs - continuous variables (Independent samples T test)

VARIABLES ANALYSED	Cases (mean)	Controls (mean)	p-value
Age (in years)	34.00	36.04	0.149
Body mass index (Kg/m^2)	**20.44**	**22.45**	**<0.0001**
Duration of service in years	**7.38**	**10.81**	**0.006**

IMPORTANT FACTORS AFTER UNIVARIATE ANALYSIS

Table 1.3.26

VARIABLES ANALYSED	p VALUE	ODDS RATIO	95% C.I. OF ODDS RATIO
Administative services personnel	0.030	0.336	0.126-0.897
Area of employment medical wards	0.002	5.618	1.838-17.17
Years duration of service	0.020	1.99	1.114-3.57
Frequent contact with patients present	0.003	2.339	1.328-4.120
Body mass index <19 Kg/m^2	0.003	2.603	1.395-4.855
Residence in hospital campus	0.001	2.885	1.561-5.332
Residence off both campuses	<0.001	0.313	0.171-0.574
Employed in microbiology department	0.063	7.437	0.899-61.52

Factors that significantly associated with tuberculosis in health care workers at the end of multiple logistic regression, after adjusting for all inter-variable interactions table1.3.27

	p-value	Odds ratio	95.0% C.I.for Odds ratio	
			Lower	Upper
Frequent patient contact present	.621	1.218	.558	2.661
Residence in hospital campus	.655	.583	.055	6.198
Residence off both campuses	.307	.283	.025	3.187
Area of employment medical wards	.033	3.693	1.114	12.247
Occupational subgroup administrative services	.450	.659	.224	1.944
Duration of service =/< 4 years	.800	1.096	.538	2.235
BMI< 19 Kg/m2	.002	2.823	1.456	5.475

After multivariate analysis and after adjusting for all the inter-variable interactions, the factors that were independently associated with the risk of acquiring tuberculosis were, having body mass index<19 Kg/m^2 [OR_2.823, 95% CI_1.456-5.475, p-value 0.002] and the area of employment being the medical wards [OR_3.693, 95% CI_1.114-12.247, p-value 0.033].

DISCUSSION

Tuberculosis in a major public health problem in India. India is classified along with the sub-Saharan African countries to be among those with a high burden and the least prospects of a favorable time trend of the disease as of now (Group IV countries). The average prevalence of all forms of tuberculosis in India is estimated to be 5.05 per thousand, and the prevalence of smear-positive cases 2.27 per thousand (13).

There are only a limited number of studies that have looked at the burden of this disease among health care workers in India. Pai et al in Gujarat showed that a large proportion of the health care workers were latently infected; 360 (50%) were positive by either tuberculin skin testing or interferon-gamma assay, and 226 (31%) were positive by both tests(31). The average incidence of smear-positive cases is 84 per 1, 00,000 annually in India (13). Our study has reported a 132% higher incidence rate of smear positive cases [111.06 cases per 100,000 population] in the year 2003. Smear positive cases formed about 35.29% of the total number of cases. However the tuberculosis situation differs in different parts of the country, as evidenced from the differences in the annual infection rate of tuberculosis reported from different regional centers. The disease incidence varies from 100 cases of tuberculosis per 100,000 population in Bangalore area (urban and rural) to 300 cases per 100,000 population in the Chennai slums and in the Wardha district. Our study reported an overall incidence rate of 314.68 per 100,000 population during the year 2003. This is more than the highest rates

reported in these Indian trials. This shows that the health care workers in India are exposed to a higher risk of acquiring tuberculosis than in the community.

Researchers from other developing countries have also looked at the incidence of tuberculosis among health care workers. The reported incidence rates has varied from as low as 96 per 100,000 in Turkey (15) to as high as 5780 per100, 000 in Malawi. In western countries the incidence of tuberculosis disease has been much less, ranging from 11 cases per 100,000 in Scotland to 380 per 100,000 in California. A recent cohort study conducted in Hong Kong revealed surprisingly no excess risk of tuberculosis among health care workers as compared to the general population (18). This study may have underestimated the risk because of the failure to standardize for age or because the working population is younger and has a lower incidence of tuberculosis than the general population. The findings of our study regarding the incidence of tuberculosis was similar to that of other studies from developing countries and also demonstrated a much higher incidence rate than those usually found in developed countries.

Prevalence/incidence by age:

Community studies have shown that both prevalence and incidence rise with age, in both sexes, in surveys conducted so far in the country. The rise is seen in all categories of case, namely radiological, culture positive and smear positive in the community (50). From the latest information on the proportional distribution of smear positive prevalence cases in the community by age (1984-1986), it could be observed that, of the prevalent cases in the community, the age-wise proportion of cases were substantially higher 35-44 yr onwards, to be at

the peak for the age group 55- 64 yr (28.40%) (51). Moreover, it remains as high as 22.67 per cent in 65 + age group, being similar to that in 45-54 yr. This could be contrasted to the distribution proportions of 1.54 and 7.25 per cent in age groups, 15-24 and 25-34 yr, respectively. In a study conducted in Sabah, Malaysia, age was found to be an independent risk factor (52). Every single year increase in the age of the health care worker increased the risk of tuberculosis by 15% (Odds ratio=1.15).The age-wise proportional distribution of smear-positive cases for India, diagnosed both under the NTP and RNTCP, combined for the year 2000 reveals peak concentration in the 25-34 yr age group, reducing thereafter. Our study shows a rather narrow distribution curve with the mean age group being 34 ± 9.79 years. The 75th percentile was at 37 years. Thus our study shows a trend of higher prevalence in the younger age group. The reasons for this include, a younger population of health care workers being employed, partly due to the high staff attrition rate since our institution is a training institution. Many of the workers employed in high risk areas like medical wards are young nurses and residents, putting them at increased risk of exposure and disease. Also the younger workers may be having a high rate of sub-clinical tuberculosis infection, conferring immunity against re-infection when they grow older. The mean age distribution was not different in the cases and controls when age was analyzed as a risk factor (34 years vs 36.04 year, in the case and control arm respectively).The situation of less than expected detection of cases in older age groups, as observed under the NTP/RNTCP in India, was attributed to deficient attendance of the symptomatics in older age groups at the general health service

facilities, *i.e.*, not commensurate with the likely prevalence of tuberculosis among them, as was highlighted by Chakraborty (53) in 1981, based on data in the Bangalore study. However this is unlikely in our setting and more over we have demonstrated a trend to a greater delay in diagnosis of cases among the fresh recruits.

Distribution of prevalence and incidence by gender:

The prevalence of disease by sex and age in the BCG trial area in Chingleput (50) showed that the prevalence and incidence in all categories of diagnosis had increased with age in males. For female, up to 45-49 yr age, the rates had increased, to be at a plateau thereafter. At all ages the prevalence was considerably higher in males than in females. Of all culture positive case, 79 per cent were found to be in males. In the later TRC follow up study 1968-1986, the average male/female ratio was 3.7 for culture positive cases and 4.5 for smear positive cases (51). Jelip et al also have shown male sex to have a higher incidence of tuberculosis in health care workers (OR_2.8416, p-value 0.0143) (52). However, paradoxically our study has shown a much higher proportion of cases in females (57.4%). One reason could be that a majority of the nurses (29.22% of total HCWs) and technical workers (16.5% of total HCWs) were females. However, when we looked at sex as an independent risk factor we found that there is no significant difference in the sex distribution between the cases and controls.

Duration of service

The duration of service was significantly different between the cases and controls, and was much lower in the cases (7.38 years vs 10.81 years, *p*-value=0.006). The proportion of cases compared to controls, was maximum in the less than or equal to 4 years duration of service group. The high incidence in this age group may be due to the younger age of the new recruits, a larger proportion of the nursing staff being nursing interns and fresh graduates, higher exposure to cases of tuberculosis as in the case of resident nurses and doctors, inter-personnel transmission due to accommodation in hostels during the initial years of service. The re-infection rate may be low in the subsequent years of service due to the high rate of sub-clinical tuberculosis infection in the initial few years of service. Pai et al has shown in Gujarat that a large proportion of the health care workers were latently infected; 50% were positive by either tuberculin skin testing or interferon-gamma assay (31). This high rate of latent infection may confer some degree of immunity during the later years.

Area of employment

The high risk areas in our institution included the isolation ward where cases of smear and culture positive tuberculosis were admitted, the medical wards were a large number of patients with prolonged cough and other respiratory symptoms were admitted for evaluation and treatment, the pulmonary function lab, the bronchoscopy suite, the pulmonary medicine wards and the microbiology lab. In our study only being employed in the medical wards was identified as an independent risk factor. This association remained statistically

significant after multivariate logistic regression analysis. One of the reasons for this increase might be the delay in the diagnosis of tuberculosis in patients admitted with chronic cough and respiratory symptoms to the medical wards, exposing personnel performing high risk procedures like nurses and respiratory therapists to risk of infection and disease. It has been shown that the institutional risk of transmission was poorly correlated with number of patients admitted with tuberculosis and better correlated with indicators of patient care such as delayed diagnosis and treatment and overall tuberculosis-related patient mortality (60). In this study initiation of appropriate treatment was delayed 1 week or more in 30%. This was associated with atypical clinical and demographic patient characteristics, and after adjustment for these characteristics, with admission to hospitals with low TB admission rate of 0.2-3.3 per 10,000 admissions or intermediate TB admissions of 3.4-9.9/10,000 as well as potentially preventable (late) intensive care unit admission (OR: 16.8; CI: 2.0,144) and death (OR: 3.3; CI: 1.7,6.5). In one study from Malaysia, it was demonstrated that medical ward health care workers have a significantly higher risk of a positive tuberculin skin test reaction than surgical or orthopedic ward health care workers (odds ratio, 2.18; 95% confidence interval, 1.33 to 3.57; P = .002 for TST positivity at 10 mm or greater) (32).

The failure to detect an association between developing tuberculosis and exposure to patients in the other high risk areas may have reflected misclassification. Also the study may not be powered for detecting these risk factors due to the smaller number of patients studied. There was a trend for

employment in microbiology lab to be associated with tuberculosis cases as compared to controls. The X-ray rooms in the radiology department, was another area which could be a potential exposure site. It was surprising that there was only one patient who reported area of employment as tuberculosis isolation ward. A larger proportion of those cases who left the institution, and hence not included in this study, could probably have worked in the isolation ward thus causing classification bias.

Department of employment

Of the different departments only microbiology was associated with a significant risk of association with tuberculosis (OR_7.447, *p*-value=0.03, 95% CI_0.899-61.67). Different studies have looked at the annual infection rates with tuberculosis in the different hospital departments.

Blumberg et al showed that being part of the house staff in the Department of Medicine was associated with independent risk of transmission of tuberculosis (54). In many other developed countries like in Canada, high-risk work setting (OR, 2.93; 95% CI, 1.44-5.95) were associated with a positive tuberculin skin test result (39). In our study Department of Medicine was not associated with an increased risk of acquiring tuberculosis. This might be due to a selection bias as many of the previous residents and interns who acquired tuberculosis prior to 2003 would have left the institution and were not enrolled in the study. Being employed in the nursing department also could be associated with a significant risk of acquiring tuberculosis, as shown in Turkey, where 59% of the new tuberculosis cases were found to be in young nurses (55). Employees

of the nursing department formed 41.58% of the total number of tuberculosis cases. In the controls 30% were employees were from nursing services. Even in the 2003 statistics nurses formed 29.2% of the work population. Hence this finding cannot be explained by a disproportionate over representation of nurses in the control population. Factors like increasing use of respiratory protection by nurses and regular change of posting of nurses that are being carried out, which limit their exposure to high risk settings might explain the apparent lower incidence in the nursing services staff.

Occupational subgroup

In our study there was an apparent lesser incidence of tuberculosis in the administrative services personnel. This can be explained by the lesser degree of direct patient contact in this group. Similar findings were found in yet another study (56) conducted by Joyce Louther et al who assessed the risk of tuberculin conversion according to occupation among health care workers at a New York City hospital. In their study the finance group had the lowest rates of conversion (2.5/100 person years). In their study occupation was associated with a significant risk of tuberculin conversion. Occupational subgroups like doctors and nursing staff are not shown to have an increased risk can be explained by the high attrition rates in these subgroups. A study in Malawi showed patient attendants to have higher rates of TB than nurses, ward attendants and doctors, but otherwise there were no significant differences between the HCW categories. We suspect that this finding could be confounded by the amount of non-occupational exposure to tuberculosis in the community. In a study performed by

Thomas Bailey et al (44), only the percentage of low-income persons within the employee's residential postal zone [odds ratio 1.39 (CI, 1.09 to 1.78); P = 0.0075] was independently associated with tuberculin skin test conversion. However our study was not able to accurately classify the occupational subgroups based on community tuberculosis exposure.

Education:

In our study the education level was not associated with the risk of acquiring tuberculosis. Education level may serve as a surrogate marker of the socio-economic level in the case of health care workers in India. The survey carried out in Wardha District (Maharashtra) is the only source of survey data in India linking tuberculosis in the community to socio-economic criteria (53). The prevalence rates in the survey had depended on literacy (lowest in the graduates and highest among the illiterates), employment held (highest among the professionals, followed by cultivators and agricultural labour). These had also depended on income, living standard (those living in "*Kutcha*" houses had a higher prevalence than "*pucca*" house dwellers). However such a distribution could not be demonstrated in our study. A graduate degree or higher level of education was not associated with reduction in the risk for tuberculosis.

BCG vaccination

BCG vaccination did not confer protection against tuberculosis in the health care worker setting. A large scale community-based double blind randomized controlled trial was carried out in Chingleput district of south India by tuberculosis research centre, Chennai, to evaluate the protective effect of BCG

against bacillary forms of pulmonary tuberculosis. There were 560 cases (189, 191 and 180 from the high dose, low dose and placebo groups respectively) arising over 15 years, among 109,873 persons who were tuberculin negative and had a normal chest X-ray at intake. The incidence rates in the three “vaccination” groups were similar confirming the complete lack of protective efficacy, seen at the end of 15 years of follow up (57). Hence our results too confirm to earlier findings regarding efficacy of BCG vaccine.

Residence

The staff members of our institution were residence wise distributed into three different groups, those who have their houses in the hospital campus, those residing in the college campus and the third group residing away from both these campuses in the community. The distance between the hospital and college campuses was 7 kilometers. The effect of the community level exposure on the development of tuberculosis was studied. The postulate was that if the cases acquired tuberculosis through predominant non-occupational exposure then the incidence among those residing in the community off both the campuses will be higher than that of those residing in the hospital campus. In a study performed by Thomas Bailey et al (44), only the percentage of low-income persons within the employee's residential postal zone [odds ratio 1.39 (CI, 1.09 to 1.78); P = 0.0075] was independently associated with tuberculin skin test conversion. However our results showed that the incidence of tuberculosis was much higher in those residing in the hospital campus (OR_2.886, 95% CI_0.001, *p*-value 0.001) as compared to those staying in the community. This finding is

confounded by the fact that only those staff who are routinely involved in the clinical care of patients like medical and surgical residents and the nursing staff are accommodated in the hospital campus. These groups are known to be at high risk of acquiring tuberculosis. On multivariate analysis too this factor was found to be not significant.

Co-morbid conditions

Patients with diabetes mellitus are also at a higher risk of tuberculosis. This has been highlighted by several retrospective and prospective studies. In a study in Mumbai, tuberculosis was found to be the most common complicating illness (5.9%) in a large cohort of over 8000 patients with diabetes mellitus (58). In a recent study from the Regional Institute of Medical Sciences, Imphal, the prevalence of pulmonary tuberculosis in diabetics was found to be 27% by radiological diagnosis and 6% by sputum positivity. A rising prevalence of tuberculosis in diabetes has been seen with age. Mortality rates in these patients are reported to be several times higher than in non-diabetic pulmonary tuberculosis patients. However in our study we did not find an association between diabetes and tuberculosis in health care workers. The reasons could be good glycemic control in health care workers with tuberculosis. The most common collagen vascular disease was SLE in our population. Immunosuppressive therapy was not associated with an increased risk of tuberculosis in our study. This could be due to the small number of patients with immunosuppression that was studied.

Body mass index

Body mass index <19 Kg/m^2 was identified to be an independent risk factor associated with tuberculosis among health care workers, on multivariate analysis. Malnutrition and wasting are associated with tuberculosis and micronutrient deficiencies have been described in individuals with tuberculosis. Compared with normal controls, tuberculosis patients are known to have significantly lower body mass index, skin fold thicknesses, mid-upper arm circumference, proportion of fat, and concentrations of serum albumin. Weight loss was present in 21.8% of our patients as one of the presenting complaints and in some cases was the only presenting complaint. Hence if we took the weight while cases presented with tuberculosis, it would be low compared to controls due to the recent weight loss and cannot be considered a risk factor for tuberculosis. .Hence in order to study low body mass index as an independent risk factor for tuberculosis we took the BMI documented one year prior to acquiring tuberculosis as the risk factor. On multivariate analysis BMI<19 Kg/m^2 was found to be an independent risk factor associated with tuberculosis.

Respiratory protection and high risk procedures

The efficacy of standard surgical masks in preventing the inhalation of droplet nuclei with a diameter of 1 to 5 mm is less than 50 %. Only high-efficiency particulate air filters (HEPA masks), tested to filter 99.97 percent of 0.3-mm particles, can ensure protection against tuberculosis (i.e., protection from droplet nuclei that are 1 to 5 mm in diameter).However facial-seal leakage in many users

and the high cost limits its use in many developed countries. Recent recommendations from the WHO, consider personal respiratory protection as the third line of defense for TB control, indicated when TB risk cannot be adequately reduced by administrative and engineering controls. In our study neither exposure to high risk procedures nor lack of regular use of personal respiratory protection during these procedures was associated with a higher incidence of tuberculosis. These findings may be due to recall bias and misclassification of cases. Lack of knowledge on use of respiratory protection or modes of transmission was not associated with a higher incidence of tuberculosis. These findings arise probably because those cases that developed tuberculosis would learn more about the disease and how they could have possibly prevented the disease. This brings about a bias in the findings on subsequent interviews regarding knowledge on modes of tuberculosis transmission and prevention.

Case control study on factors causing a delay in the diagnosis of tuberculosis among health care workers

A delay in the diagnosis of tuberculosis increases the risk of poor clinical outcome including death and transmission of tuberculosis. There was a significant delay in diagnosis of cases of tuberculosis (mean delay of 37.98 days). There was a non significant trend for the more than mean delay in the diagnosis of tuberculosis to be associated with employees who are in their first four years of service (OR_2.226, p-value_0.05, 95%CI_0.994-4.981). This finding could reflect patient delays and poor utilization of effective health care by fresh

recruits. Further studies may be required to look at this finding. Sputum negative pulmonary tuberculosis was associated with a less than mean delay in diagnosis. This finding can be explained by the following facts. Of the 24 smear negative pulmonary tuberculosis cases, 19 had pleural effusion (79.16%). In our institution the protocol for evaluation of exudative pleural effusion involves pleural biopsy, pleural fluid analysis, AFB smear of the pleural fluid, and pleural biopsy tissue culture. The combined diagnostic yield of these procedures is more than 91%. Also the patients with pleural effusion tended to present earlier due to pleuritic chest pain and fever. These factors lead to an early diagnosis in many of these patients. Many studies have reported bone tuberculosis to be associated with a significant delay in diagnosis. In our series also bone tuberculosis was associated with a mean delay of 47.20 days. It is interesting to note that even in smear positive/ sputum culture positive pulmonary tuberculosis there is a mean delay of 40.24 days. This would lead to significant nosocomial transmission both to other health care workers and to patients. Hence in order to decrease this delay in diagnosis reeducation and communication regarding optimal use of medical facilities should be conducted especially targeting high risk groups.

LIMITATIONS

- A selection bias could have happened since some health care workers had left the institution before they could be enrolled in the study.
- For parameters like knowledge regarding tuberculosis and the use of respiratory protection there might be recall bias.
- Tuberculosis infection rates were not analyzed in this study either by repeat tuberculin testing or by newer modalities like IFN-gamma assay.
- Regarding the delay in diagnosis of cases, the delay should be further sub analyzed in terms of patient delay and health care/physician delay.

CONCLUSIONS

- Health care workers had a higher incidence of tuberculosis than the general population. The incidence of tuberculosis disease among health care workers was 314 cases per 100,000 person years. The incidence of sputum positive pulmonary tuberculosis was 111.06 per 100,000 person years.

- The main sub type of tuberculosis was sputum positive pulmonary. Among the extra pulmonary cases tuberculous lymphadenitis constituted the majority.

- Among health care workers at our institute the only risk factors that were independently associated with tuberculosis were a body mass index <19 Kg/m^2 and employment in medical wards.

- No occupational subgroups were found to have an independently increased risk for acquiring tuberculosis.

- There was a significant delay in diagnosis of cases of tuberculosis. The mean delay was 37.98 days. The delay in the diagnosis of smear positive cases could contribute to nosocomial transmission of tuberculosis.

- There was a non-significant trend for more than greater delay in diagnosis of tuberculosis among fresh recruits in their first four years of service.
- Our findings call for intensification of appropriate tuberculosis control activities in the hospital setting and education of high-risk groups, to reduce the diagnostic delay thereby reducing the nosocomial transmission of TB.

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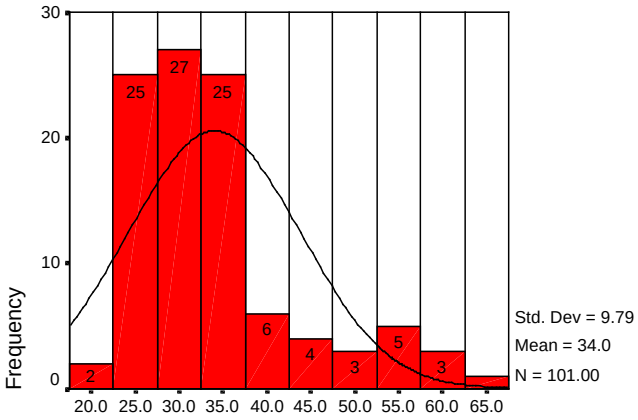
ANNEXURE

ANNEXURE I

FIGURES AND GRAPHS

Age distribution of cases

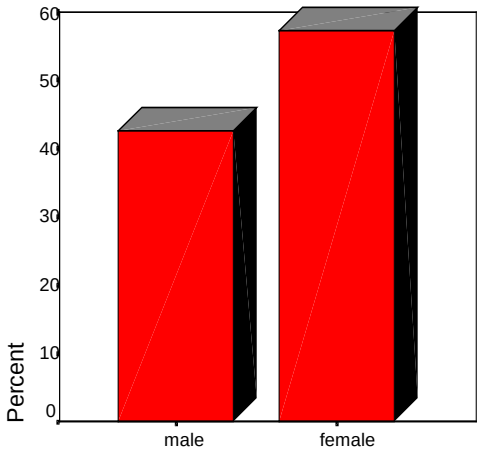
figure 1.1.01



AGE

sex distribution of cases

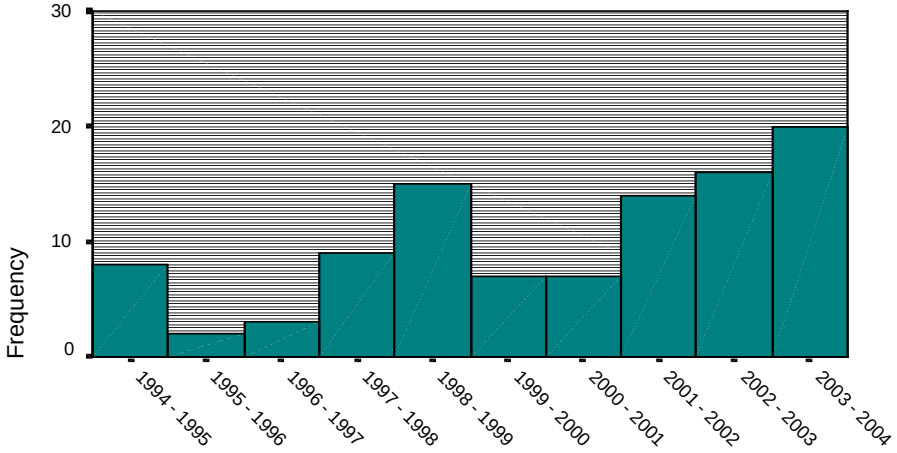
figure 1.1.02



sex

year of diagnosis

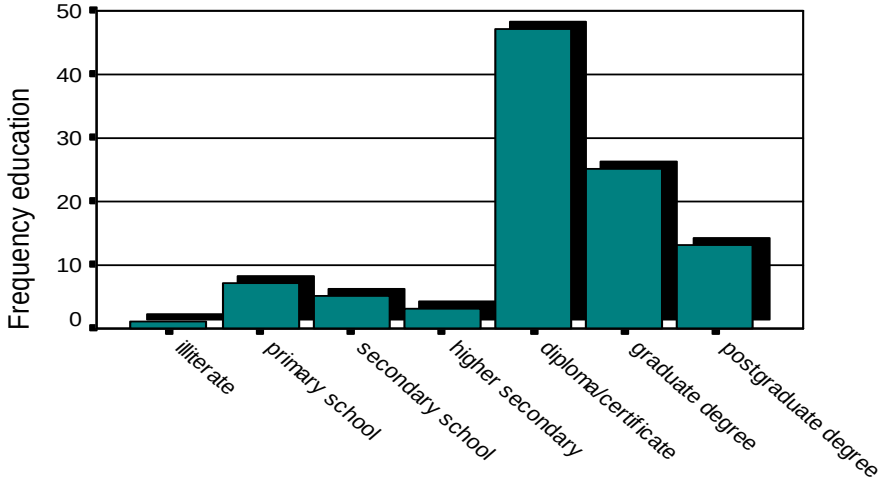
figure 1.1.03



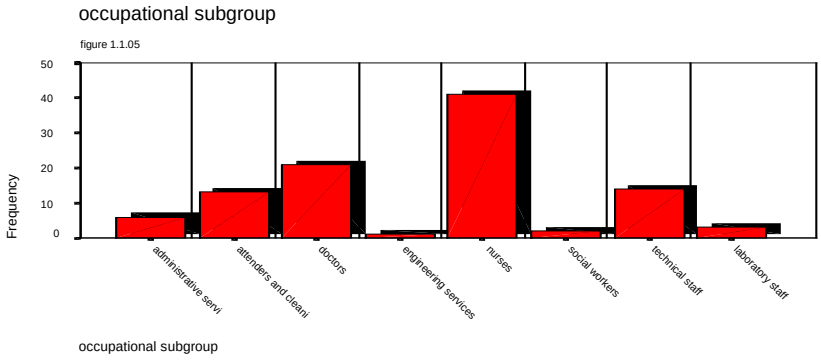
year of diagnosis

distribution of cases by education

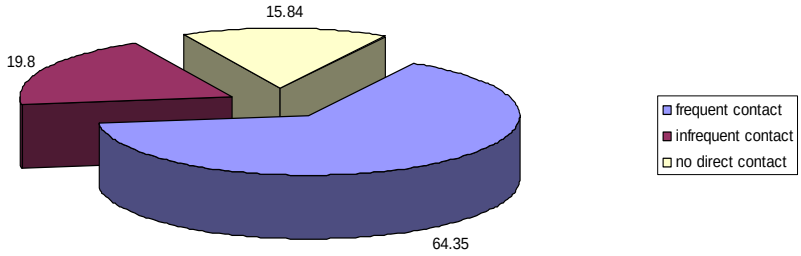
figure 1.1.04

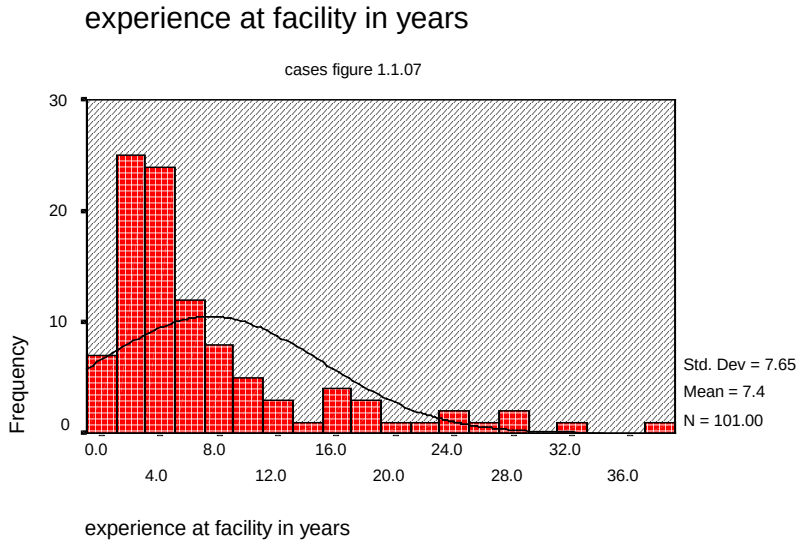


education

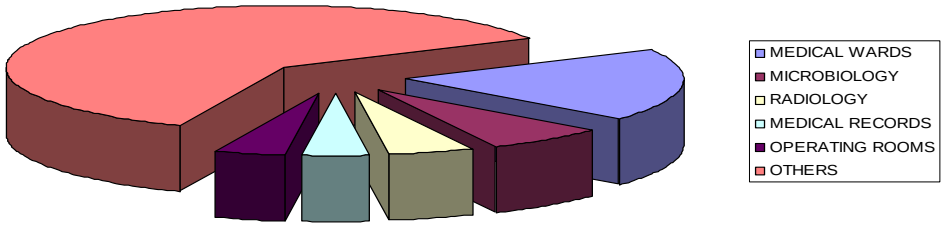


HCW Contact with patients figure 1.1.06

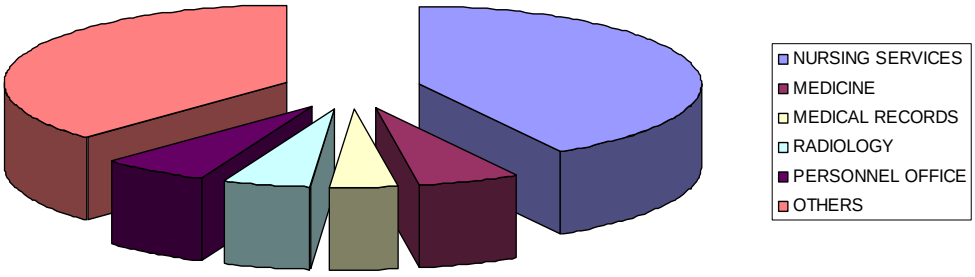


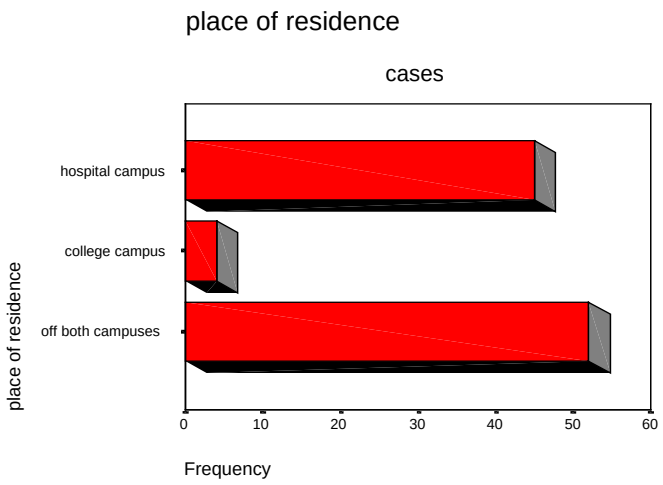


AREA OF EMPLOYMENT OF CASES figure 1.1.08

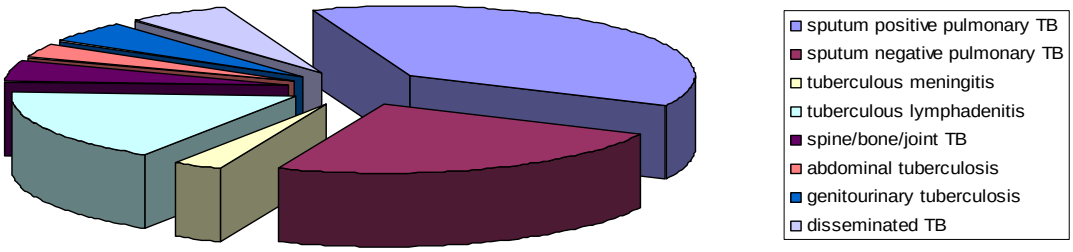


department wise distribution of cases figure 1.1.09



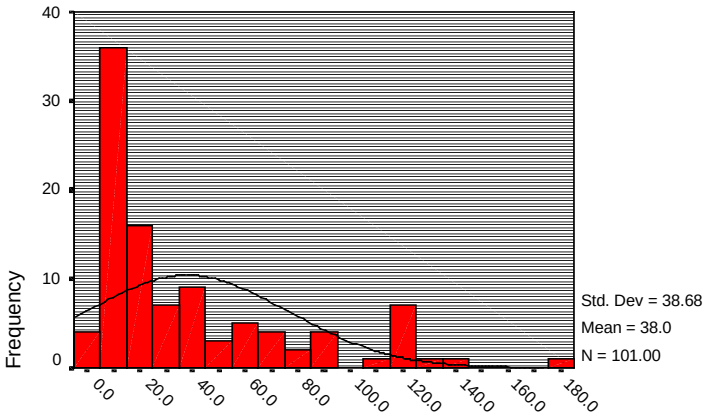


Subtypes of tuberculosis figure 1.1.11

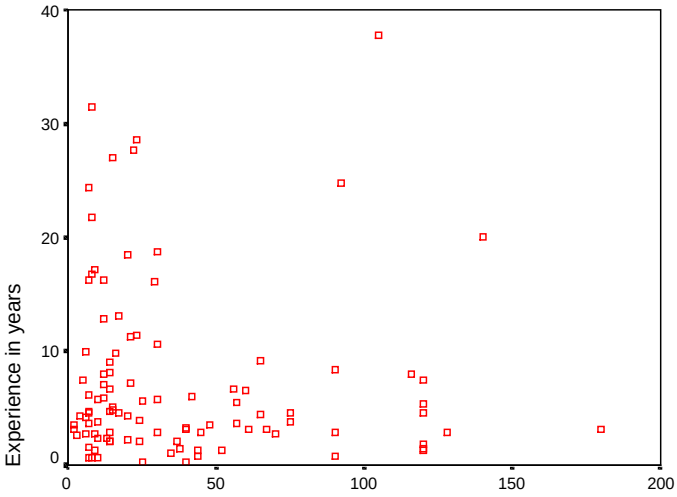


delay in diagnosis of cases

figure 1.1.12



duration of onset of symptoms to diagnosis



duration of onset of symptoms to diagnosis (days) figure 1.1.13

ANNEXURE II

PROFORMA

PROFOMA FOR HEALTH CARE WORKER-TUBERCULOSIS STUDY [HCW-TB STUDY]:

First contact with investigator:

Code number:

HOSPITAL NUMBER:

Date of enrollment: (_ _/_ _/_ _) (dd/mm/yy)

Group at enrollment: **Case/ In-hospital control** (1/2)

Date of bith:

Sex: male/female (1/2)

Education:

1=illiterate 2 =primary school 3=secondary school 4= higher secondary

5=diploma/certificate course 6=graduate degree 7=postgraduate degree holder.

8=doctoral

Occupational subgroup

1=Administrative services, 2=Attenders and cleaning staff, 3=Doctors, 4=Engineering services , 5=Library services, 6=Nurses, 7=Social workers, 8=Teaching staff, 9=Technical staff, 10=Laboratory staff, 11=Others

Contact with patients:

1=frequent 2=infrequent 3=no direct contact.

Income:

1= upto Rs.2500

2= Rs.2500-4999

3= Rs.5000-7499

4= Rs.7500-10,000.

5=More than Rs.10000.

Date of joining the health facility: (_ _/_ _/_ _) (dd/mm/yy)

Presence of BCG vaccination/BCG scar: yes/no (1/2)

Height (in centimeters):_ _ _

Weight (in Kilograms):_ _ _

Main area of employment in the past one year:

Department:

History of known non-occupational exposure to tuberculosis in the past six months:

Place of residence:

1=Hospital campus 2=College campus 3=Off campus(mention place)

Family history of contact with tuberculosis 1.yes 2.no

Co morbid conditions:

0=nil 1=Diabetes mellitus 2=Hypertension 3=Chronic renal failure 4=Liver disease 5= Ischeamic heart disease 6=Chronic obstructive airway disease 7=Connective tissue disorders

Immunosuppressive therapy (chronic steroid use, other immunosuppressents):

1.present 2.absent

Smoking

1.current smoker 2.ex-smoker 3.non-smoker.

Exposure to high risk procedure:1.exposed 2.not exposed.

[Any procedure that is cough producing: ryles tube insertion, bronchoscopy, sputum induction, drug administration through a nebulizer machine etc]

Use of respiratory protection during the previous mentioned high risk procedure1.yes 2.no 3.unable to recall 4.not applicable.

Knowledge on the use of respiratory protection in prevention of TB infection

1.good 2.poor

Knowledge on the mode of TB transmission

1.good 2.poor.

Previous TST: 1. positive 2. negative 3.not done

Date__/__/__ Result_____

CASES:

Date of diagnosis: (_ _/_ _/_ _) (dd/mm/yr)

Diagnosis:

1=Sputum positive pulmonary tuberculosis 2=Sputum negative pulmonary tuberculosis

3=Tuberculous meningitis 4=Tuberculous lymphadenitis 5=Spine /Bone/Joint tuberculosis

6=Abdominal tuberculosis 7=Genito-urinary tuberculosis 8=other extra pulmonary / disseminated tuberculosis.

Duration from onset of symptoms to diagnosis (in days):

Presenting complaints:

1= fever 2=cough 3=weigh loss 4=hemoptysis 5=lymph node enlargement 6=malaise 7=central nervous system manifestations (headache, altered sensorium, vomiting, obtundation etc) 8=others

Number of days of work lost

LABORATORY PARAMETERS:

Sputum AFB smear:

Result:1= Positive

A=few AFB B=Moderate AFB C=numerous AFB

2=Negative 3=not done

	Date	Result	
Specimen 1:			
Specimen 2:			
Specimen 3:			

AFB culture result: Date:

Date of reporting:

1.positive 2.negative3.not done

Source of specimen:

1.sputum 2.CSF 3.pleural fluid 4.lymphnode 5.others 6.not applicable

Sensitivity report:

Histopathology:

1.granlomatous inflammation consistent with TB

2.negative for tuberculosis

3.not done

Hemoglobin in grams (_ _)

ESR in millileters at one hour (_ _)

Total leukocyte count percubic millimeters:

Total lymphocyte count:

Creatinine in mg% (_ _)

Chest Xray:1.normal 2.abnormal

ANNEXUREIII

INFORMED CONSENT FORM

TITLE OF THE STUDY: The clinical profile of tuberculosis among health care workers at the Christian medical college hospital, Vellore.

INSTITUTION: Department of Medicine, Christian Medical College and Hospital; Staff Students Health Clinic, CMC Vellore.

HOSPITAL NO.:

NATURE AND PURPOSE OF THE STUDY: You are being asked to take part in a research study to determine the clinical profile of tuberculosis among health care workers at the Christian medical college hospital, Vellore. The aim of this research project is to identify the risk factors for tuberculosis among the hospital employees.

EXPECTED DURATION OF INVOLVEMENT: Duration of assessment will be for about 45 minutes on the first day of enrollment and at completion of the anti tuberculous therapy as applicable.

POSSIBLE BENFITS OF THE STUDY: The outcome of the study will help us to know the clinical profile and risk factors of tuberculosis among health care workers. The study may not benefit you directly..

CONFIDENTIALITY: Your records and all details obtained in this study will remain strictly confidential at all times, but will need to be available to the doctor conducting the study. Your identity will not otherwise be revealed. Your personal data collected will be processed only for research purposes in connection with this study. You will not be referred to by name or identified in any report or publication.You are free to leave the study at any time. Your decision not to participate in this study will not affect your present or future medical care.

CONSENT: I have read/ had read to me above information before signing this consent form.

SIGNATURE OF THE SUBJECT:

SIGNATURE OF THE PERSON OBTAINING CONSENT:

DATE:

Master Data Sheet(Cases)

sl no	birthyr	sex	educat	occupatn	ptcontac	income	joindate	bcg	height	weight	areaempl	dept	exposure
1	1979	2	5	6	1	3	14-Jul-1997	1	154	40	BWARD	NURSING SERVICES	2
2	1968	1	4	2	2	2	1-Aug-1992	1	160	46	A K LAB	NEPHROLOGY	2
3	1979	2	5	6	1	2	3-Oct-1979	2	160	65	Q3 WARD PMR	NURSING SERVICES	2
4	1974	2	5	6	1	3	22-Feb-1999	1	151	50	A K LAB	NURSING SERVICES	2
5	1981	2	5	6	1	2	28-Jul-1999	1	156	41	L WARD/HEMATOLOGY	NURSING SERVICES	2
6	1980	2	6	10	3	2	2-Aug-2001	2	163	47	MICROBIOLOGY	MICROBIOLOGY	2
7	1983	2	5	6	1	2	22-Jun-2000	2	150	42	ISOLATION WARD	NURSING SERVICES	2
8	1981	2	6	6	1	3	6-Jul-1998	1	164	48	B WARD	NURSING SERVICES	2
9	1979	2	5	6	1	2	22-Jun-1998	1	153	36	MATERNITY WARDS	NURSING SERVICES	1
10	1982	1	6	3	1	3	1-Sep-2000	1	175	67	B WARD	MEDICINE	2
11	1976	1	6	3	1	3	1-Feb-1999	1	165	49	CASUALTY	EMERGENCY SERVIC	2
12	1981	2	5	6	1	3	24-Jun-1999	1	155	31	MATERNITY WARDS	NURSING SERVICES	2
13	1981	2	6	6	1	3	3-Jul-1999	1	172	60	MEDICAL WARDS	NURSING SERVICES	2
14	1972	2	5	6	1	3	1-Aug-1991	2	160	65	Q1 WEST	NURSING SERVICES	2
15	1971	2	5	6	1	3	24-Jun-1996	1	156	30	I WARD	NURSING SERVICES	2
16	1978	2	5	1	3	3	26-Jun-1997	1	154	35	Q1 WEST	NURSING SERVICES	2
17	1981	2	5	6	1	3	20-Jun-1998	1	162	48	N 2 WARD	NURSING SERVICES	2
18	1981	2	6	6	1	3	1-Sep-1999	1	160	64	PAEDIATRIC WARD	NURSING SERVICES	2
19	1974	2	6	6	1	2	1-Jun-1990	1	162	40	N 2 WARD	NURSING SERVICES	2
20	1978	1	6	3	1	3	1-May-1998	1	163	60	B WARD	INTERN	2
21	1976	1	6	3	1	3	4-Jan-1996	1	171	44	PEDIATRIC WARDS	PEDIATRICS	2
22	1963	2	5	6	1	3	21-Aug-1984	2	164	47	ENDOSCOPY RROM	NURSING SERVICES	2
23	1959	1	2	2	2	3	1-Mar-1981	1	150	39	A K LAB	PERSONAL OFFICE	2
24	1969	1	7	3	1	3	1-Jan-1988	1	182	84	S WARD	ORTHOPAEDICS	2
25	1982	2	5	6	1	3	23-Jun-1999	1	163	63	NEURO ICU	NURSING SERVICES	2
26	1975	2	5	6	1	3	8-Jul-1995	1	152	42	K N WARD	NURSING SERVICES	2
27	1976	2	5	9	1	3	11-Nov-1999	1	152	52	DIETARY	DIETARY	2
28	1972	2	7	3	1	2	24-Jun-1996	1	155	54	E WARD	MEDICINE	2
29	1962	2	5	6	1	4	1-Mar-1985	1	148	53	ORTHO OPD	NURSING SERVICES	2
30	1953	1	6	7	2	3	4-Aug-1980	1	163	72	RUHSA	RUHSA	2
31	1971	1	7	3	1	3	11-Mar-1997	1	178	70	S WARD	ORTHOPAEDICS	2
32	1976	2	5	6	1	3	1-Jun-1996	1	151	54	OPERATING ROOMS	NURSING SERVICES	2
33	1980	2	5	6	1	3	27-Jun-1997	1	150	42	C WARD	NURSING SERVICES	2
34	1952	1	2	2	3	2	21-Mar-1985	1	156	46	CSSD	CSSD	2
35	1970	2	6	3	1	3	26-Feb-1997	1	158	54	LABOUR ROOMS	OBSTRETICS	2
36	1940	1	2	4	3	3	4-Aug-1986	2	162	43	ENGINEERING SERVI	ENGINEERING SERV	2
37	1978	2	5	6	1	3	1-Jul-1995	1	158	52	R WARD	NURSING SERVICES	1
38	1973	1	5	9	1	3	24-Aug-1993	1	164	55	RADIOLOGY DEPT	RADIOLOGY	2
39	1977	1	6	3	1	4	1-Jan-1997	1	155	52	S WARD	ORTHOPAEDICS	2
40	1970	1	7	3	3	4	4-Jun-1993	1	160	68	MICROBIOLOGY	MICROBIOLOGY	2
41	1969	2	5	6	1	4	20-Sep-1991	1	146	40	OPERATING ROOMS	NURSING SERVICES	2
42	1976	2	5	9	1	3	21-Jul-1995	2	156	70	RADIOLOGY	RADIOLOGY	2
43	1971	1	6	1	2	3	11-Jul-1997	1	158	50	MEDICAL RECORDS	MEDICAL RECORDS	2
44	1977	2	5	6	1	3	29-Jul-1998	1	150	38	LABOUR ROOM	NURSING SERVICES	2
45	1977	2	5	6	1	3	1-Jun-1994	1	173	70	B WARD	NURSING SERVICES	2
46	1946	2	1	2	2	2	17-May-1966	2	155	47	E WARD	MEDICINE	2
47	1978	2	5	6	1	3	1-Jul-1995	1	153	66	E WARD	NURSING SERVICES	2
48	1977	2	5	6	1	3	1-Jun-1997	1	150	50	COLLEGE OF NURSIN	NURSING SERVICES	2
49	1951	1	2	9	2	3	5-Jan-1971	2	166	49	ALC	ALC	2

50	1962	1	2	2	3	2	2-Jun-1969	1	160	42	STAFF CLINIC	PERSONAL OFFICE	2
51	1974	2	5	6	1	3	12-May-1997	1	157	36	B WARD	NURSING SERVICES	2
52	1973	2	5	6	1	3	8-Jul-1995	1	150	39	CASUALTY	NURSING SERVICES	2
53	1971	2	5	6	1	3	4-Jul-1991	1	163	54	REHAB INSTITUTE	NURSING SERVICES	2
54	1984	2	6	6	1	3	6-Jul-1998	1	164	56	B WARD	NURSING SERVICES	2
55	1973	2	5	6	1	3	23-Jul-1997	2	153	47	Q3W/ PEDIATRICS	NURSING SERVICES	2
56	1974	1	5	9	3	3	24-Nov-1994	1	170	57	MICROBIOLOGY	MICROBIOLOGY	2
57	1973	1	5	9	1	3	22-Aug-1994	1	173	58	RADIOLOGY	RADIOLOGY	2
58	1971	1	6	9	2	3	14-Jul-1997	1	153	55	MEDICAL RECORDS	MEDICAL RECORDS	2
59	1973	2	6	9	2	2	11-Aug-1993	2	153	50	PHARMACY	PHARMACY	2
60	1970	1	6	3	1	3	1-Jan-1990	1	164	63	MEDICAL WARDS	MEDICINE	2
61	1954	1	3	2	3	3	8-Feb-1980	2	160	36	CSSD	PERSONAL OFFICE	2
62	1971	1	7	7	2	3	3-Dec-2002	1	170	89	CEU	CLIN EPIDEMIOLOG	2
63	1977	1	7	3	1	4	1-Mar-2002	1	170	100	R WARD	RADIOTHERAPY	1
64	1973	1	6	1	2	3	9-Oct-1995	1	165	57	MEDICAL RECORDS	MEDICAL RECORDS	2
65	1978	2	7	3	1	3	9-Feb-2002	1	159	53	MHC	PSYCHIATRY	1
66	1967	1	3	2	3	2	23-Jun-1992	1	165	62	STORES	PERSONAL OFFICE	2
67	1979	2	5	10	3	3	5-Jul-1996	1	154	45	MICROBIOLOGY	MICROBIOLOGY	2
68	1976	2	5	6	1	3	21-Aug-1996	1	165	42	OPERATING ROOMS	NURSING SERVICES	2
69	1969	2	5	1	3	2	31-Jul-1992	1	155	40	PFT LAB	PULMONARY MEDINC	2
70	1981	2	5	6	1	3	1-Jun-1998	2	153	45	MEDICAL WARDS	NURSING SERVICES	2
71	1961	2	7	9	1	3	24-Nov-1993	1	153	46	DIETARY	DIETARY	2
72	1971	1	6	9	2	3	1-Apr-1998	1	176	51	MEDICAL RECORDS	MEDICAL RECORDS	2
73	1970	1	4	2	2	2	24-Apr-1991	1	160	62	PHARMACY	PHARMACY	2
74	1977	2	6	3	1	3	5-Jul-2000	1	169	67	MEDICAL WARDS	INTERN	2
75	1968	2	5	9	2	3	29-Jul-1985	1	159	47	PHARMACY	PHARMACY	2
76	1976	1	6	3	1	3	1-Jan-1997	1	182	76	MICU	MEDICINE	2
77	1956	1	2	2	2	3	26-Mar-1982	2	155	45	PERSONAL OFFICE	PERSONAL OFFICE	2
78	1970	2	6	3	1	3	13-Jul-1987	1	153	40	RADIOLOGY	RADIOLOGY	2
79	1969	1	5	10	2	3	14-Oct-1996	1	165	65	BLOOD BANK	CLINICAL PATHOLO	2
80	1968	2	5	6	1	3	27-Jun-1985	1	150	33	MATERNITY WARDS	NURSING SERVICES	2
81	1975	2	6	6	1	4	8-Jul-1992	1	160	49	MEDICAL WARDS	NURSING SERVICES	2
82	1978	1	4	2	3	3	26-Feb-1998	1	160	44	MICROBIOLOGY	MICROBIOLOGY	2
83	1944	1	5	9	1	4	24-Nov-1965	2	163	54	CARDIOLOGY	CARDIOLOGY	2
84	1970	2	6	6	1	3	1-Jul-1988	1	157	50	MTS 4	NURSING SERVICES	2
85	1970	2	5	6	1	3	11-Jul-1995	1	153	62	MEDICAL WARDS	NURSING SERVICES	2
86	1967	1	7	3	3	4	20-Sep-1991	1	173	50	MICROBIOLOGY	MICROBIOLOGY	2
87	1964	2	5	6	1	3	27-Feb-1986	1	148	51	P 2 WARD	NURSING SERVICES	2
88	1964	2	7	3	2	5	1-Jan-1982	2	165	46	MICROBIOLOGY	MICROBIOLOGY	2
89	1965	2	7	9	2	3	19-Feb-1990	1	148	46	BIOSTATISTICS	BIOSTATISTICS	2
90	1977	1	3	2	2	3	1-Nov-1994	1	170	55	OPERATING ROOMS	PERSONAL OFFICE	2
91	1971	1	7	3	1	4	1-Jun-1989	1	164	68	P 2WARD	GENERAL SURGERY	2
92	1982	1	5	9	2	3	28-Jul-2000	1	173	70	RADIOLOGY	RADIOLOGY	2
93	1948	1	3	2	3	3	23-Oct-1977	1	158	41	DIRECTORATE	DIRECTORATE	2
94	1946	1	2	2	2	3	26-Apr-1993	1	160	50	ELECTRICAL	ELECTRICAL	2
95	1982	2	5	6	1	3	23-Jun-1999	1	162	42	MATERNITY	NURSING SERVICES	2
96	1952	1	5	1	3	4	27-May-1969	1	179	84	ACCOUNTS	ACCOUNTS	2
97	1982	2	5	6	1	3	21-Jun-2000	1	155	56	I WARD	NURSING SERVICES	2
98	1948	1	3	1	3	4	19-Jul-1966	2	158	60	HLRS OFFICE	HLRS	2
99	1968	1	6	3	1	3	13-Feb-1999	1	180	70	MEDICAL WARDS	MEDICINE	2

Master Data Sheet(Cases)

100	1980	2	5	6	1	3	13-Jul-1998	1	157	45	E WARD	NURSING SERVICES	2
101	1973	1	7	3	1	4	1-Mar-1999	1	168	70	R WARD	RADIOTHERAPY	2

Master Data Sheet(Cases)

residenc	comorbid	immsupp	smoking	hrproced	protect	knowprot	knowtran	familyco	tstprevi	datediag	diagnos	duration	prestcom	worklost
1	0	2	3	1	2	1	1	2	3	27-Mar-2002	1	7	2	13
3	0	2	3	2	4	2	2	2	3	23-Oct-2003	4	21	356	0
1	0	2	3	1	2	1	1	2	3	8-Feb-2004	3	7	17	30
1	0	2	3	1	1	1	1	2	1	22-Jan-2002	1	90	28	0
1	0	2	3	1	1	1	1	2	2	16-May-2003	1	75	13	18
3	0	2	3	1	1	1	1	2	1	11-Jun-2003	1	120	168	7
1	0	2	3	1	1	1	1	2	2	13-Aug-2003	1	2	123	0
1	0	2	3	1	2	1	1	2	1	28-Feb-2003	2	14	18	14
1	0	2	3	2	4	1	1	2	2	25-Aug-2001	8	67	137	75
2	0	2	3	2	4	1	1	2	2	15-Jul-2003	1	45	1236	0
1	0	2	1	2	4	1	1	2	3	1-Aug-2000	4	120	13	0
1	0	2	3	2	4	1	1	2	3	6-Feb-2002	1	3	168	30
1	0	2	3	2	4	1	1	2	3	31-Jul-2001	2	14	1	14
3	0	2	3	1	1	1	1	2	3	21-Mar-2002	1	30	2	14
3	0	2	3	1	1	1	1	2	2	15-Jan-2001	1	7	3	270
3	0	2	3	1	1	1	1	2	1	8-Sep-2001	2	6	1	3
3	0	2	3	1	1	1	1	2	3	23-Apr-2003	1	15	12	35
1	0	2	3	1	2	1	1	2	3	27-Jun-2002	1	30	23	21
1	0	2	3	1	2	1	1	2	1	14-Jan-1994	1	7	125	10
2	0	2	3	2	4	1	1	2	3	16-Jul-2001	1	40	134	45
1	0	2	3	1	2	1	1	1	3	26-Feb-2003	2	21	28	0
3	0	2	3	1	2	1	1	2	1	25-Apr-2003	8	30	136	29
3	2	2	1	2	4	2	2	2	3	9-Aug-1999	1	20	123	30
1	2	2	3	2	4	1	1	2	3	7-Jan-1995	1	12	12	16
1	2	2	3	1	1	1	1	2	3	13-Aug-2004	4	15	5	1
3	0	2	3	1	1	1	1	2	2	1-Jan-1999	4	48	1	30
1	0	2	3	2	4	1	1	2	3	31-Dec-2001	5	37	8	7
1	0	2	3	1	1	1	1	1	3	11-Apr-1997	1	90	123	30
3	1	2	3	2	4	1	1	2	3	4-Nov-2001	3	8	1	30
3	0	2	3	2	4	1	1	2	3	5-Apr-2002	2	8	13	14
1	0	2	3	2	4	1	1	2	3	6-Dec-2002	6	30	13	21
3	0	2	3	1	2	1	1	2	1	5-Feb-2003	1	14	1	30
1	0	2	3	1	2	1	1	2	3	5-Mar-1998	3	8	17	35
3	0	2	3	2	4	1	1	2	3	14-Jan-1998	1	12	12	28
1	1	2	3	2	4	1	1	2	3	7-Mar-1998	4	35	5	35
3	1	2	2	2	4	2	2	2	3	10-Jan-1998	1	23	26	40
1	0	2	3	1	2	1	1	2	3	28-Apr-1998	1	14	12	10
3	0	2	3	2	4	1	1	2	3	12-Feb-1999	1	57	1	60
1	2	0	2	2	4	1	1	2	3	17-Feb-2003	8	7	8	35
3	0	2	3	1	1	1	1	2	3	17-Apr-2003	2	16	2	14
3	0	2	3	2	4	1	1	2	3	27-Oct-2000	1	65	23	30
3	0	2	3	2	4	1	1	2	1	27-Feb-1999	8	57	8	20
3	0	2	3	2	4	2	2	2	3	20-Apr-2000	2	6	12	30
3	0	2	3	2	4	1	1	2	3	24-Feb-2003	4	17	15	30
1	0	1	3	1	1	1	1	2	1	3-Dec-2000	4	60	1	30
3	8	2	3	2	4	2	2	2	3	30-Dec-2003	6	105	8	30
1	0	2	3	1	1	1	1	2	1	6-Aug-1997	2	14	18	14
1	0	2	3	2	4	1	1	2	3	12-Aug-1997	1	40	125	14
3	2	2	1	2	4	2	2	2	3	25-Nov-1997	5	15	18	36

Master Data Sheet(Cases)

3	2	2	1	2	4	1	1	1	3	4-Mar-1994	1	92	24	30
1	0	2	3	1	1	1	1	2	3	7-Jan-1998	1	10	1	10
1	0	2	3	1	2	1	1	2	3	20-Apr-1998	1	70	3	14
1	0	2	3	1	3	1	1	2	3	27-Feb-1998	1	56	2	28
1	0	2	3	2	4	1	1	2	1	19-Aug-2000	6	24	16	15
3	0	2	3	1	2	1	1	2	2	12-Apr-1998	2	44	12	50
3	0	2	3	2	4	2	2	2	3	10-May-2002	5	120	38	40
3	0	2	3	2	4	1	1	2	3	3-Jun-2000	2	10	123	7
3	0	2	1	2	4	1	1	2	1	2-Nov-1999	4	10	5	7
3	7	1	3	2	4	1	1	2	3	10-Feb-1998	2	65	123	50
1	0	2	3	2	4	1	1	2	3	2-Mar-1998	2	14	16	15
3	0	2	1	2	4	2	2	2	3	5-Apr-1997	1	9	123	7
3	0	2	3	2	4	1	1	2	3	12-Mar-2004	7	120	8	3
1	12	2	1	2	4	1	1	2	3	26-Sep-2003	7	7	8	2
3	0	2	3	2	4	1	1	2	3	1-Feb-2000	2	20	12	7
2	0	2	3	2	4	1	1	2	3	9-May-2002	1	25	12	15
3	0	2	1	2	4	2	2	2	1	19-Jun-2002	8	6	8	1
3	0	2	3	1	1	1	1	2	3	2-Feb-2002	1	25	12	10
1	0	2	3	2	4	1	1	1	3	31-Dec-2001	4	120	135	14
3	0	2	3	2	4	2	1	2	1	3-Feb-1997	1	75	12	14
1	0	2	3	2	4	1	1	2	1	24-Sep-1999	2	44	1	20
1	7	2	3	2	4	1	1	2	3	10-Oct-1996	4	128	5	30
3	0	2	3	2	4	1	1	2	3	26-Nov-1998	4	7	12	7
3	0	2	3	2	4	2	2	2	3	30-Apr-1999	1	116	38	30
2	16	2	1	2	4	1	1	2	1	10-Sep-2003	7	180	8	7
3	0	2	3	2	4	2	1	2	3	12-Sep-2001	2	29	12	30
3	0	2	3	1	2	1	1	2	3	27-Jan-2003	5	42	8	10
3	1	2	1	2	4	2	2	2	3	25-Mar-2002	1	140	124	60
1	0	2	3	2	4	1	1	2	3	8-Dec-1995	4	90	5	2
3	0	2	3	2	4	1	1	2	3	30-Apr-2001	7	120	1	30
3	0	2	3	1	1	1	1	2	3	21-Jul-1998	2	17	12	15
3	0	2	3	1	1	1	1	2	3	6-Apr-1996	2	10	18	15
3	0	2	1	2	4	2	2	2	3	27-Jun-2002	1	4	2	60
3	8	2	1	2	4	2	2	2	3	18-Mar-1997	2	8	2	30
1	0	2	3	1	2	1	1	2	3	9-May-1994	4	12	5	14
1	0	2	3	1	1	1	1	2	3	17-Oct-1996	2	9	28	13
1	0	2	1	1	1	1	1	2	3	30-Jun-1994	2	9	12	25
3	0	2	3	1	1	1	1	2	3	10-Feb-1994	2	12	28	24
1	8	2	3	2	4	1	1	2	1	5-Mar-1998	4	7	5	10
3	0	2	3	2	4	1	1	2	3	14-Aug-1993	2	2	24	10
3	0	2	3	2	4	1	1	2	3	25-Apr-2002	4	5	5	7
1	0	2	3	2	4	1	1	2	2	30-Jun-1998	4	14	12	26
3	0	2	3	2	4	1	1	2	3	9-Jan-2002	2	38	12	25
3	0	2	3	2	4	2	2	2	1	20-Jan-1994	1	12	12	40
3	0	2	3	2	4	2	2	2	1	12-Mar-1997	1	24	12	20
1	0	2	3	2	4	1	1	2	3	4-Nov-2001	1	13	12	30
3	28	2	3	2	4	1	1	2	3	10-Nov-1997	4	23	1	10
1	0	2	3	1	1	1	1	2	3	26-Oct-2001	2	52	18	23
3	28	2	3	2	4	1	1	2	3	6-Feb-1994	5	22	1	28
1	6	2	3	2	4	1	1	2	3	12-May-2001	7	20	8	10

Master Data Sheet(Cases)

1	0	2	3	1	1	1	1	2	1	12-Sep-2001	1	40	2	17
1	0	2	3	2	4	1	1	2	3	1-May-2002	8	61	38	26

Master Data Sheet(Cases)

afbsmr	mycultur	culsourc	histopat	hemoglob	esr	wbccount	lymph	creat	chestxry	relapse
1	2	1	3	11.70	35	5,800	2,030	0.60	2	2
3	3	6	1	10.30	8	10,800	432	0.90	1	2
2	2	2	3	11.20	45	8,200	1,804	0.70	1	2
2	1	1	3	13.10	30	7,900	1,738		2	2
2	1	1	3	9.80	75	7,100	1,704		2	2
1	1	1	3	11.10	105	5,400	1,242	0.70	2	2
1	1	1	3	10.70	94	8,200	2,050	0.60	2	2
2	2	3	3	12.50	30	9,100	1,547		2	2
2	2	2	1	9.50	53	9,300	1,302	0.70	2	2
1	3	6	3	12.70	76	8,700	1,305	1.00	2	2
3	3	6	3	12.50					1	2
1	3	6	3	10.70	8	17,300	1,903	0.60	2	2
2	1	3	3	12.70	7	6,300	756	0.80	2	2
1	2	1	3	11.40	43	7,700	2,233	0.90	1	2
2	1	1	3	10.90	50	7,600	1,976	0.80	2	2
2	2	1	3	12.50		6,500	1,170		2	2
1	1	1	3	9.50	46	5,700	1,140	0.70	2	2
1	1	1	3	11.10	45	7,100	1,562	0.80	2	2
2	1	1	3	11.50	90	9,900	990		2	2
1	1	1	3	13.90	75	9,200	1,564		2	2
2	2	1	3	16.20	20	5,400	1,512	1.00	2	2
2	2	5	1	13.00	45	5,600	840	0.80	1	1
1	3	6	3	13.30	56	16,900	2,028		2	1
1	3	6	3	14.70	4	8,400	2,856		2	2
3	2	4	1	12.60	55				2	2
2	1	4	1	11.90	15	7,400	1,554		1	2
3	1	5	3	11.30	40	7,700	1,309	0.70	1	2
1	3	6	3	11.20	10	5,600	1,568		2	2
3	1	2	3	12.70	60	9,600	2,496	0.60	1	2
3	2	3	1	14.90	12	7,600	1,216	1.00	2	2
2	2	1	2	12.30	20	7,100	5,538	1.30	1	2
1	3	6	3	11.90	24	8,170	2,124		2	2
3	1	2	3	11.60	25	8,400	3,108	0.90	1	2
1	1	1	3	15.00	7	7,700	1,925		2	2
3	3	6	1	13.80	45	9,200	1,840	0.80	1	2
1	1	1	3	12.50					1	2
1	1	1	3	12.90	75	6,700	1,340		2	2
1	1	1	3	15.00	6	7,500	1,500		2	2
3	1	4	1	12.70	25	8,100	1,863	1.00	2	2
3	2	3	1	12.30	25	7,600	912	1.00	2	2
1	1	1	3	7.90	90	8,600	1,892	0.90	2	2
2	1	1	1	10.40	95	9,000	1,260	0.90	2	2
3	2	3	1	14.60	5	7,300	2,190	0.80	2	2
2	2	4	1	13.20	0!	5,400	1,836		1	2
3	1	4	1	11.00	66	8,500	2,210		1	2
3	2	5	1	12.40	63	16,400	492	0.70	1	2
2	2	1	1	9.50	80	7,600	6,004		2	2
1	1	1	3	9.90	85	9,600	1,248	1.00	2	2
3	1	5	1	15.70	95	29,000	3,770	0.90	2	2

Master Data Sheet(Cases)

1	1	1	3	13.00	60	4,700	1,504		2	2
1	1	1	3	10.50	40	7,000	5,250	0.80	2	2
2	1	1	3	9.40	0!	5,300	2,438		2	2
1	1	1	3	12.70	22	10,000	2,300	0.90	2	2
2	2	5	3	11.80	56	8,100	5,670	0.70	1	2
2	3	1	13	30.00	30	4,500	1,395	1.00	1	2
2	1	5	3	14.80	69	5,300	954	0.60	1	2
3	1	1	3	16.90	10	6,800	952		2	2
3	3	6	1	12.00	50	5,300	2,120		1	2
2	2	1	3	10.30	35	4,000	600	0.60	2	2
3	1	3	3	15.30	5	7,800	2,886	1.10	2	2
1	1	1	3	13.90	95	11,500	1,725	0.90	2	1
2	2	5	1	12.40	8	6,800	2,380	1.10	1	2
2	3	6	1	14.80	30	11,200	2,464	1.00	1	2
3	2	3	1	15.40	100	8,500	1,360	1.00	2	2
1	3	6	3	11.50	80	11,500	1,610	0.70	2	2
3	3	6	1	15.30	5	7,800	2,886		1	2
1	2	1	3	12.50	30	7,500	2,336		2	2
3	2	4	1	13.80	42	8,700	3,045	0.90	2	2
2	1	1	1	10.50	25	6,200	1,364		2	2
2	2	1	3	13.00	115	1,600	114		2	2
3	3	6	1	13.10	20	6,670	2,734	0.80	1	2
3	3	6	1	14.80		9,500	2,755	0.90	1	2
2	1	1	1	11.10	2	5,500	1,375	0.90	2	2
2	1	5	2	13.00	45	12,600	3,024	0.80	1	2
3	2	3	1	9.50	100	9,300	1,116	0.70	2	2
3	1	5	1	14.60	7	7,400	1,998	1.10	1	2
2	1	1	3	14.30	101	10,500	1,470	0.70	2	2
3	3	6	1	10.60	74	6,500	2,100	0.60	1	2
2	2	5	1	12.40	5	16,800	2,184	0.90	1	2
2	2	3	1	12.10	120	4,300	344		2	2
2	2	5	3	10.60	90	8,170	1,944	0.90	2	2
1	1	1	3	16.10	36	7,900	1,975	1.00	2	2
2	2	1	2	11.50	38				2	2
3	3	6	1	13.40	15	6,000	2,340		1	2
3	2	3	1	11.40	45	11,100	2,775	0.90	2	2
2	1	5	1	13.50	95	6,400	1,728	0.90	2	2
2	1	3	3	12.50	88	8,400	1,936	0.70	2	2
3	1	4	1	11.00	55	8,900	1,602	0.90	1	2
2	2	1	3	14.90	18	15,200	1,520	1.10	2	2
3	3	6	1	12.30		11,000	2,900		1	2
2	2	4	1	11.60	60	6,400	1,216	1.10	2	2
2	2	3	1	12.00	92	5,500	1,045	1.10	2	2
1	1	1	3	12.10	118	12,000	2,880		1	2
1	1	1	3	12.40	64	6,400	1,088	0.80	2	2
1	2	1	3	10.60	110	9,600	3,456		2	2
3	2	4	1	11.80	40	4,400	792	1.50	1	2
3	1	5	1	12.90	92	9,100	1,092		2	2
2	2	1	1	10.80	68	12,100	3,388	1.40	1	2
3	3	6	1	14.00	15	6,900	1,449	1.00	1	2

Master Data Sheet(Cases)

1	1	1	3	12.90	32	9,600	1,728		2	2
3	3	5	1	12.50	88	6,000	1,620	1.00	2	2

Sl no	birthyr	sex	educat	occupatn	ptcontac	income	joindate	bcg	height	weight	areaempl	dept	exposure	residenc	comorbid	immsupp
1	1975	2	5	1	3	3	27-Dec-1997	1	147	43	STORES	STORES	2	3	0	2
2	1974	1	5	1	3	3	21-Mar-2002	1	157	59	DIRECTORATE	PERSONAL OFFICE	2	3	0	2
3	1975	1	7	3	1	4	27-Jan-2003	1	180	70	U WARD	UROLOGY	2	1	0	2
4	1964	2	5	1	3	4	11-Aug-1987	1	148	52	VIROLOGY	VIROLOGY	2	3	6	2
5	1963	1	3	2	3	3	30-Oct-1985	1	150	71	CSSD	CSSD	2	3	0	2
6	1981	1	6	10	3	3	20-Jan-2003	1	164	58	CLINICAL PATHOLOGY	CLINICAL PATHOLOGY	2	3	0	2
7	1981	2	6	3	1	4	2-Jun-2004	2	150	51	DENTAL	DENTAL	2	1	0	2
8	1975	2	5	9	1	4	8-Aug-1996	2	150	53	DIETARY	DIETARY	2	3	6	2
9	1974	1	7	3	1	4	4-Oct-2004	1	170	80	H WARD	ENDOCRINOLOGY	2	1	2	2
10	1960	1	6	4	3	4	18-Sep-1984	1	155	60	ENGINEERING	ENGINEERING	2	3	12	2
11	1969	2	6	3	1	4	17-Jan-2005	1	157	63	MEDICINE OPD	MEDICINE I	2	1	0	2
12	1959	1	3	2	3	2	16-Jun-1982	1	150	50	HOSP ANNEXE	HOSP ANNEXE	2	3	0	2
13	1966	1	6	1	2	3	1-Apr-1999	1	177	77	MEDICAL RECORDS	MEDICAL RECORDS	2	3	7	2
14	1969	2	6	3	1	4	28-Jan-2005	1	154	71	EMERGENCY SERVICES	CASUALTY	2	1	0	2
15	1972	1	5	4	3	3	20-Mar-1997	1	168	53	TELEPHONE EXCHANGE	TELEPHONE EXCHANGE	2	3	0	2
16	1975	1	7	1	3	2	16-Oct-2002	1	156	45	ACCOUNTS	ACCOUNTS	2	3	0	2
17	1946	1	5	1	3	4	1-Dec-1965	1	166	81	ACCOUNTS	ACCOUNTS	2	3	2	2
18	1984	1	5	9	2	2	29-Jun-2002	2	164	52	OPERATING ROOMS	ANAESTHESIA	2	3	0	2
19	1975	2	7	1	2	3	28-Nov-1998	1	150	50	CARDOLOGY OFFICE	CARDIOLOGY	2	3	8	2
20	1976	1	7	3	1	4	15-Mar-2004	1	174	80	J WARD	CARDIOLOGY	2	1	0	2
21	1977	2	6	9	3	3	28-Mar-2003	1	160	48	BIOCHEMISTRY	BIOCHEMISTRY	2	3	7	2
22	1961	2	4	1	3	3	4-Aug-1983	1	150	55	CEU	CEU	2	3	2	2
23	1977	2	6	10	3	3	30-Jun-2000	1	155	62	BLOOD BANK	CLINICAL PATHOLOGY	2	3	8	2
24	1977	1	5	4	3	2	27-Oct-1999	1	155	58	COLLEGE MAINTENANCE	COLLEGE MAINTENANCE	2	3	0	2
25	1966	1	5	4	3	4	7-Apr-1988	1	157	60	A/C MAINTENANCE	ENGINEERING	2	3	8	2
26	1966	1	4	4	3	3	8-Jun-1998	1	158	50	BOILER ROOM	ENGINEERING	2	3	0	2
27	1975	2	5	6	1	4	21-Sep-1999	1	173	44	PAEDIATRIC WARD	NURSING SERVICES	2	3	0	2
28	1973	2	5	6	1	3	22-Nov-1995	1	148	57	RENAL UNIT	NURSING SERVICES	2	3	0	2
29	1981	2	5	6	1	3	20-Jan-2003	1	152	52	LCECU	NURSING SERVICES	2	1	8	2
30	1971	1	6	1	3	3	5-Aug-1996	1	160	52	MEDICAL RECORDS	MEDICAL RECORDS	2	3	6	2
31	1973	1	3	2	3	2	22-Mar-2000	1	155	67	NAMBIKANILAYAM	MENTAL HEALTH CENTRE	2	3	0	2
32	1974	2	5	6	1	3	2-Jul-2003	1	155	54	K N WARD	NURSING SERVICES	2	3	0	2
33	1979	2	5	6	1	3	5-Nov-2003	1	161	46	C WARD	NURSING SERVICES	2	3	0	2
34	1966	2	5	6	1	3	29-Aug-2000	1	145	71	MTS 2	NURSING SERVICES	2	3	2	2
35	1950	1	3	2	3	3	6-Feb-1980	2	158	65	HOSPITAL ANNEXE	HOSPITAL ANNEXE	2	3	0	2
36	1956	1	6	1	2	4	3-Feb-1984	1	153	62	MEDICAL RECORDS	MEDICAL RECORDS	2	3	0	2
37	1980	2	6	9	1	2	30-Oct-2004	1	165	67	PHYSIOTHERAPY GYM	PHYSICAL MEDICINE	2	3	0	2
38	1980	2	5	6	1	3	30-Jul-2004	1	153	47	MEDICAL ICU	NURSING SERVICES	2	1	0	2
39	1949	2	5	6	1	4	4-Jan-1975	1	148	54	LCECU	NURSING SERVICES	2	3	12	2
40	1950	2	5	1	3	5	1-Nov-1975	1	153	44	INTERNAL AUDIT	ACCOUNTS	2	3	0	2
41	1972	2	6	6	1	4	6-Aug-1993	1	145	42	M 2 WARD	NURSING SERVICES	2	3	0	2
42	1972	1	5	1	3	3	25-Jun-1999	1	168	73	OPERATION THEATRE	OPERATION THEATRE	2	3	8	2
43	1945	2	5	6	1	5	8-Apr-1963	1	155	55	OPTHALMOLOGY	NURSING SERVICES	2	3	12	2
44	1951	1	5	1	3	3	24-Oct-1981	2	166	69	OPTHALMOLOGY	OPTHALMOLOGY	2	3	0	2
45	1972	1	5	4	3	3	21-Jun-1995	1	176	54	OPTHALMOLOGY	ELECTRICAL	2	3	0	2
46	1962	2	5	6	1	4	18-Dec-1984	1	153	53	CSSD	NURSING SERVICES	2	3	0	2
47	1979	2	5	6	1	3	16-Nov-2004	1	150	45	M 3 WARD	NURSING SERVICES	2	1	0	2
48	1970	2	5	6	1	3	26-Sep-2003	2	161	72	LABOUR ROOM	NURSING SERVICES	2	3	0	2
49	1976	2	5	6	1	3	27-Jun-1997	1	153	50	NURSERY	NURSING SERVICES	2	1	0	2

50	1984	2	5	6	1	3	28-Jun-2001	1	164	51	E WARD	NURSING SERVICES	2	1	0	2
51	1978	2	5	6	1	4	5-Nov-2003	1	150	47	KN ICU	NURSING SERVICES	2	1	0	2
52	1947	2	5	6	1	4	30-Jan-1969	1	162	67	RADIOLOGY	NURSING SERVICES	2	3	0	2
53	1975	2	5	6	1	3	6-Jul-2003	1	161	45	H WARD	NURSING SERVICES	2	3	0	2
54	1970	2	5	6	1	3	29-Sep-2000	2	150	34	EMERGENCY SERVICES	NURSING SERVICES	2	3	68	2
55	1981	2	5	6	1	3	19-Jan-2004	1	153	37	R WARD	NURSING SERVICES	2	1	0	2
56	1955	1	3	2	3	3	1-Jan-1980	2	155	42	STAFF CLINIC	SSHS	2	3	8	2
57	1974	2	7	3	2	4	22-Jul-1992	1	153	61	RADIOLOGY	RADIOLOGY	2	1	0	2
58	1973	2	5	6	1	4	23-Mar-1993	1	157	50	P 2 WARD	NURSING SERVICES	2	3	8	2
59	1960	2	5	10	3	4	7-Mar-1992	1	155	67	BLOOD BANK	CLINICAL PATHOLOGY	2	3	8	2
60	1965	2	4	1	3	3	31-Dec-1997	1	148	53	PRINCIPALS OFFICE	PRINCIPAL`S OFFICE	2	3	0	2
61	1971	2	5	6	1	4	9-Aug-1995	1	170	65	OPTHALMOLOGY WARDS	NURSING SERVICES	2	3	0	2
62	1970	2	5	9	3	3	13-Apr-1999	1	148	43	PHARMACY	PHARMACY SERVICES	2	3	0	2
63	1977	1	4	2	2	3	22-Mar-2002	1	163	48	OPERATING ROOMS	PERSONAL OFFICE	2	3	0	2
64	1949	2	2	2	3	3	9-Aug-1973	2	148	41	Q 1 EAST WARD	PERSONAL OFFICE	2	3	0	2
65	1973	1	3	2	3	2	22-Jul-2002	1	165	57	LAUNDRY	LAUNDRY	2	3	0	2
66	1970	2	5	1	3	3	16-Feb-1996	1	153	60	PURCHASE DEPARTMENT	PURCHASE DEPARTMENT	2	3	0	2
67	1976	1	7	3	1	5	1-Jun-1994	1	172	70	SURGICAL WARDS	GENERAL SURGERY	2	1	0	2
68	1964	2	2	2	3	2	13-Jul-1990	1	145	40	BLOOD BANK	CLINICAL PATHOLOGY	2	3	0	2
69	1955	1	7	3	1	5	14-Jun-1976	1	176	86	EMERGENCY SERVICES	EMERGENCY SERVICES	2	2	0	2
70	1970	1	3	2	3	2	26-Mar-2001	1	155	56	MENS HOSTEL	PERSONAL OFFICE	2	3	0	2
71	1979	2	5	6	1	3	24-Jun-1998	1	150	49	Q 5 EAST	NURSING SERVICES	2	3	0	2
72	1971	1	3	2	2	2	26-Jun-1997	1	155	53	B WARD	PERSONAL OFFICE	2	3	1	2
73	1959	1	2	2	2	3	22-Jun-1984	1	165	47	MTS 4 WARD	PERSONAL OFFICE	2	3	0	2
74	1957	1	6	7	3	2	12-Aug-2004	1	168	60	MENTAL HEALTH CENTRE	PSYCHIATRY	2	3	0	2
75	1958	1	6	1	3	5	12-Jan-1987	1	172	93	RUHSA	RUHSA	2	3	2	2
76	1967	1	3	2	3	2	15-Nov-1989	1	163	64	REGISTRAR`S OFFICE	REGISTRAR`S OFFICE	2	3	0	2
77	1960	1	7	5	3	4	25-Oct-1992	1	165	66	LIBRARY	CHAPLIANCY	2	3	2	2
78	1970	1	7	3	1	5	11-Jan-2003	1	173	79	MATERNITY WARDS	OBSTRETICS/ GYNEC	2	1	0	2
79	1980	2	6	6	1	3	30-Jun-2000	1	165	42	NURSERY	NURSING SERVICES	2	3	0	2
80	1981	2	4	2	2	2	13-Sep-1999	1	154	44	G 3 SOUTH WARD	PERSONAL OFFICE	2	3	0	2
81	1978	1	4	2	2	2	22-Jun-1998	1	160	49	EMERGENCY SERVICES	EMERGENCY SERVICES	2	3	0	2
82	1946	1	2	2	3	3	20-Jul-1970	1	155	56	HOSPITAL MAINTENANCE	HOSPITAL MAINTENANCE	2	3	8	2
83	1976	2	5	6	1	3	27-Oct-1997	1	145	54	MEDICAL LEUKEMIA UNIT	NURSING SERVICES	2	3	0	2
84	1955	2	3	2	2	3	23-Oct-1992	2	155	54	B WARD	PERSONAL OFFICE	2	3	0	2
85	1978	1	6	3	1	4	24-Jul-1996	1	173	69	N 1 WARD	NEUROSURGERY	2	1	0	2
86	1971	1	3	2	2	2	26-Mar-1990	1	160	42	G 4 SOUTH WARD	PESONAL OFFICE	2	3	0	2
87	1982	1	6	3	1	3	1-Jun-1999	1	175	50	NURSERY	PAEDIATRICS	2	1	0	2
88	1952	1	6	9	2	4	5-Jun-1993	2	157	53	RUHSA	RUHSA	2	3	2	2
89	1973	1	6	9	3	3	11-Oct-1995	1	157	54	MEDICAL RECORDS	MEDICAL RECORDS	2	3	0	2
90	1976	2	6	6	1	3	8-Jul-1997	1	155	54	RUHSA	NURSING SERVICES	2	3	8	2
91	1972	2	5	6	1	4	6-Jun-1994	1	151	43	SURGICAL ICU	NURSING SERVICES	2	1	0	2
92	1970	1	7	3	1	4	28-May-2001	1	150	52	I WARD	ENT	2	1	0	2
93	1969	1	3	2	2	2	4-Dec-1995	1	157	49	REHABILITATION CENTRE	PERSONAL OFFICE	2	3	0	2
94	1946	1	3	2	3	3	6-Nov-1973	1	162	54	PAEDIATRIC SURGERY	PAEDIATRIC SURGERY	2	3	1	2
95	1980	2	5	6	1	3	20-Jun-2001	1	157	47	ENDOSCOPY SUITE	NURSING SERVICES	2	1	0	2
96	1953	2	7	6	1	5	9-Jan-1992	1	148	62	L WARD	NURSING SERVICES	2	3	126	2
97	1971	1	3	2	3	2	7-Aug-1991	2	156	60	EMERGENCY SERVICES	EMERGENCY SERVICES	2	3	0	2
98	1968	2	3	2	2	2	5-Aug-1992	1	147	50	MATERNITY WARDS	PERSONAL OFFICE	2	3	0	2
99	1981	2	5	6	1	3	1-Jan-2005	1	155	39	ENDOSCOPY SUITE	NURSING SERVICES	2	1	0	2

100	1976	2	6	10	3	5	5-Oct-1976	1	155	57	MICROBIOLOGY	MICROBIOLOGY	2	3	0	2
101	1979	1	5	9	2	3	24-Jun-1998	1	167	61	RADIOLOGY	RADIOLOGY	2	3	0	2

smoking	hrproced	protect	knowprot	knowtran	familyco
3	2	4	2	2	2
3	2	4	2	2	2
3	2	4	1	1	2
3	2	4	1	1	2
3	2	4	2	2	2
1	2	4	1	1	2
3	1	1	1	1	2
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