Original Article

A Study of Quarterly Trend of Infectious Tuberculosis and Evaluation of Tuberculosis Control Program in Post Conflict Sierra Leone, 2002-2005

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ABSTRACT

This study aimed to measure the impact of directly observed treatment short-course (DOTS) coverage on notification of infectious tuberculosis (TB) and treatment cure rate in the post conflict period of 2002 to 2005 in Sierra Leone. The study was a population based retrospective study on implementation of DOTS expansion by the National Leprosy TB Control Program (NLTCP). Data recorded in district TB registers and TB annual reports were analysed for trend of infectious TB registered quarterly, treatment cure rates and number DOTS centres opened per annum. A trend analysis of proportion of infectious TB (sputum smear positive) to all TB cases reported to the central program each quarter during the periods 2002 to 2005 was plotted. However, this did not appear to show any discernable pattern but the following observations were made. In 2003 the lowest proportion of infectious TB cases was reported. Furthermore, there appeared to be a decline in proportion of infectious TB cases reported in the third quarter of each year, corresponding to the peak of the rainy season. An evaluation of DOTS expansion based on Donabedian's triad showed that 76% of the target set for 2005 was achieved; that is, 53 of the targeted 70 DOTS centres were opened by the end of 2005. A correlation-regression analysis gave a correlation coefficient (R) of 0.22 which suggests a weak relationship between treatment cure rate and district population DOTS coverage. The implementation of DOTS expansion by the NLTCP considerably improved DOTS coverage and treatment cure rates in the immediate post conflict period of 2002 to 2005. However, there was a weak association between district DOTS coverage and treatment cure rates, and its impact on trend of infectious TB notification was limited during this period.

INTRODUCTION

The 10-year rebel war, which ended officially in 2001 left Sierra Leone in socioeconomic decline and ranked amongst the least developed countries in United Nation Development Programme 'Human Development Index' (GOSL, 2005). Sierra Leone is divided into 14 administrative districts (Figure 1) (DACO-SLIS, 2007). The population of Sierra Leone was estimated at 4.97million based on the 2004 census with an estimated 37.1% of the population dwelling in urban townships (Thomas, 2007). The proportion of the population living in urban townships and environs may have been much higher during the conflict period due to internal displacement of the rural population to refugee camps and relatives in urban towns. The impact of rebel war and trends of urbanisation the world over is associated with urban poverty, overcrowding and increased morbidity and mortality (Moreno and Warah, 2006).

Poverty and overcrowding are some of the known contributing factors for spread of tuberculosis (TB). *Mycobacterium tuberculosis* infection may result in pulmonary TB disease, a highly infectious disease or extra-pulmonary disease (Heymann, 2004). Pulmonary TB is infectious when respiratory droplets containing TB bacilli are coughed, sneezed or discharged with secretions by persons infected with TB (WHO, 2004).The World Health Organisation (WHO) reported in

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2005 that over a third of the world population were infected with TB, with the majority of morbidity and mortality reported from the low-income countries (WHO, 2007).

To combat the spread and reduce the burden of TB, WHO in collaboration with the International Union Against Tuberculosis and Lung Diseases (IUATLD) and other partners introduced the directly observed treatment short-course (DOTS) strategy (Enarson *et al.*, 2000). In Sierra Leone, the DOTS strategy for prevention and control of tuberculosis has been implemented by the national control program for over a decade and includes making high quality diagnosis and treatment of TB easily accessible to all, with sustained government commitment (GOSL, 2003). The aim of this study is to measure the impact of DOTS expansion on notification of infectious tuberculosis and treatment cure rate in the post conflict period of 2002 to 2005.

STUDY POPULATION AND METHODS
### Study Setting and Design
The study design was a population based retrospective study and was based on the 2004 population census. The National Leprosy TB Control Program (NLTCP) implements the DOTS strategy in all fourteen administrative districts of Sierra Leone (Figure 1). The programme has a supervisor and TB assistant(s) in each of the districts who submit reports quarterly on TB cases detected and recorded in the district TB register to the central programme. The main indicators considered for this study were; proportion of infectious TB (i.e. those with sputum smear positive TB of all TB cases recorded per quarter by the NLTCP), number of DOTS centres and DOTS coverage, treatment cure rate in each district. The treatment cure rate is defined as the proportion of sputum smear positive TB cases who are completely cured with bacteriology evidence (converted to smear negative) after treatment to all TB cases reported in the cohort. The NLTCP based diagnosis of sputum smear positive TB on identification of TB bacilli by standardised acid fast bacilli microscopy. The study was approved by the Ministry of Health and Sanitation, Sierra Leone.

Data Collection and Analysis
Data from the district TB register and annual TB reports for 2002 to 2005 was analysed. The district TB registers contained summary data on TB cases detected in the district collected from source documents; treatment cards, facility and laboratory registers. These source documents contain medical relevant data on each TB suspect or case that is screened or treated for TB in every DOTS centre. The data recorded include demographic such as age and sex, the category of TB case i.e. pulmonary sputum smear positive (PTB ss+ve), pulmonary sputum smear negative (PTB ss-ve) and extra-pulmonary (EPTB). The treatment outcome reported on includes cured, treatment completed, defaulted, treatment failure and died. For the purpose of this study the treatment cure rate was considered the most appropriate treatment outcome indicator, as the others were small in magnitude and variation negligible. The treatment cure rate was PTB ss+ve patients only, and did not include treatment completed which is the treatment outcome for PTB ss-ve and EPTB. The annual report contained summary information on TB control activities in each district for the year, cohort analysis, and other program interventions such as number of DOTS centres operational in each district.

The data was collated using Microsoft excel. Data analysis was done using Epi info 2000 for windows version 3.4.3. The analysis of quarterly trends of proportion of infectious /sputum positive TB was computed thus: (Number of PTB ss+ve cases X 100/Total number of TB cases). For this study those reported to be PTB ss+ve were regarded as infectious TB. The evaluation of program performance involved the measurement of certain indicators against set targets. The Donabedian's triad model which involved the measurement of structural, process and outcome indicators against set targets or objectives was adopted for the study (Ader *et al.*, 2001).
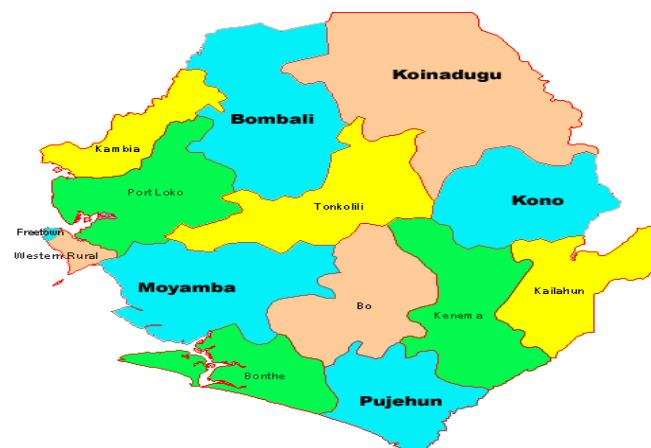
Figure 1: Map of Sierra Leone showing Districts
(Source:www.election-sl.org/wards.html
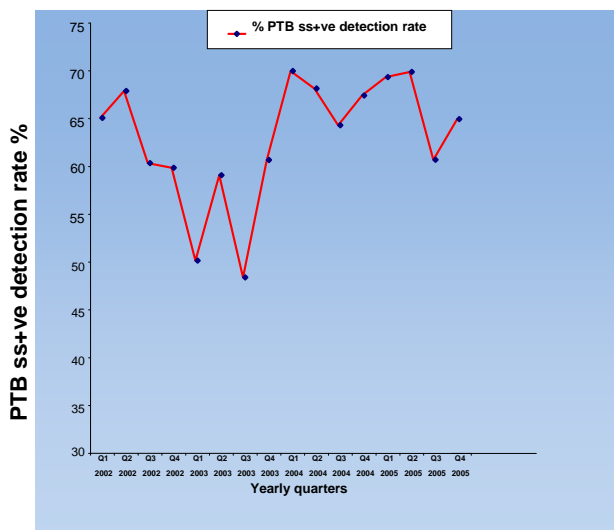[Accessed on 17th April 2008])

RESULTS

Quarterly Trends of Proportion of Infectious TB

The quarterly trend of proportion of infectious TB diagnosed by the program between the periods 2002 to 2005 did not appear to show any discernable pattern (Figure 2). In spite of this, a few observations were noted. Firstly, the proportion of infectious TB in the early part of 2002 appeared as high as that in 2004 and 2005, whilst 2003 reported the lowest proportion of infectious cases. Secondly, there appeared to be a decline in proportion of infectious TB diagnosed in the third quarter of each year, corresponding to the peak of the rainy season. However, the absolute number of all TB cases detected has continued to increase annually.

Table 1: Comparison of treatment cure rate (%) with number of DOTS centre in the district 2002 and 2005

| Districts	Number of DOT centres in 2002	Treatment cure rate (%), 2002	Number of DOT centres in 2005	Treatment cure rate (%), 2005	District population coverage per DOTS centre
Western area urban	7	78	8	78	98,363
Western area rural	1	-	4	82	41,006
Portloko	3	81	6	83	75,838
Bombali	3	-	3	75	106,998
Moyamba	2	86	2	86	129,809
Bo	1	82	4	92	76,444
Kenema	1	83	4	93	87,515
Kono	1	-	2	74	126,865
Koinadugu	1	74	1	67	234,330
Kailahun	-	-	5	87	71,652
Kambia	1	-	4	74	69,247
Tonkolili	1	70	6	76	57,647
Bonthe	2	66	2	84	65,149
Pujehun	1	71	2	88	117,117
Total	25	-	53	-	-

Figure 2: Trend of Quarterly PTB ss+ve Reported, 2002 - 2005

On appraisal of the data sources with the checklist, only ten of the fourteen districts reported on TB cases in the district registers in 2002. This incompleteness in reporting may explain the apparent high proportion of infectious TB seen in the early part of 2002.

The lack of reporting in four districts Bombali, Kambia, Kailahun and Western area rural was attributed to the displacement of the district population and destruction of health facilities during the conflict.

Evaluation of Program Performance

This evaluation of program performance included a measure of DOTS coverage (structure and process indicators) and treatment cure rate (outcome indicator). The target set for DOTS expansion by 2005 was to establish 70 DOTS centres. In addition, DOTS coverage at the district population level was set in accordance WHO/IUATLD guidelines, which recommend a range of 50,000 to 150,000 population per DOTS centre depending on incidence of TB in the country (Enarson et al., 2000). In Sierra Leone with high TB burden and poor health infrastructure, district coverage of 70,000 population per DOTS centre was the target set by the NLTCP. A comparison of district population coverage per DOTS centre is shown in Table 1. The number of DOTS centres increased from 25 in the year 2002 to 53 in 2005.
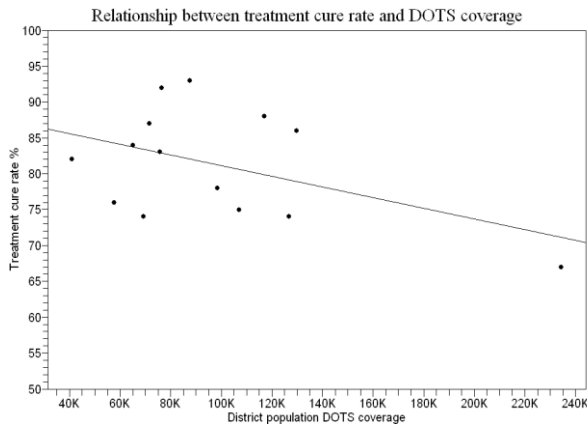
Figure 3: Relationship between Treatment Cure Rate and DOTS Coverage

This was accompanied by better coverage of the population and improvement in treatment cure rates. In 2002, only one district, Moyamba achieved a treatment cure rate above the WHO target of 85%, whilst by 2005 this was achieved by five districts, namely Bo, Kenema, Kailahun, Moyamba and Pujehun (Figure 1). The evaluation of DOTS expansion showed that 76% of the target set for 2005 was achieved; that is, 53 of the targeted 70 DOTS centres were opened by the end of 2005. Though the target was not achieved, the program continued to make yearly progress towards set targets. In terms of DOTS coverage, only four of the 14 districts achieved the set target by 2005 (Table 1). These were Bonthe, Kambia, Tonkolili and Western area rural (Figure 1).

The last aspect of the evaluation of the programmes performance was to examine the association between district population DOTS coverage and treatment cure rate of each district (Figure 3). The correlation - regression analysis gave a correlation coefficient (R) of 0.22. This suggests that there is a weak relationship between treatment cure rate and district population DOTS coverage, and that treatment outcome especially treatment cure rate may have been influenced by other factors.

DISCUSSION

The main goal of the programme is to reduce the burden of TB in Sierra Leone, with the aim of achieving the Millennium Development Goals (MDGs) and Stop TB partnership targets by 2015. The MDGs were agreed upon by the United Nations general assembly in 2000, to combat extreme poverty, hunger, maternal and child mortality, disease, inadequate shelter, gender inequality, environmental degradation and develop Global Partnership for Development.

Goal 6 was to halt and reverse trends of morbidity and mortality due to HIV, Malaria, TB and other major diseases (UNDP, 2010)

The PTB ss+ve cases as a proportion of all TB cases registered quarterly over the study period were an important measure of the impact of DOTS expansion. This also served as a proxy measure of the sensitivity of TB diagnosis in the programme DOTS facilities. The proportion of PTB ss+ve cases by quarter over the study period ranged from 48.40% to 70.33%. This range of PTB ss+ve is consistent with annual proportion of PTB ss+ve of 57% and 72% reported in 2002 and 2005 by WHO (WHO, 2005; 2007). In addition, these were comparable with findings in a study in the Hadiya zone, southern Ethiopia which reported yearly sputum positivity averaging 46% (range 40 -50%) (Shargie and Lindtjorn, 2005).

The apparent high proportion of PTB ss+ve in 2002 may be a reflection of poor health status of the population as a consequence of the rebel war which ended in 2001 and thus a backlog of TB cases gained access to DOTS facilities and hence diagnosed with TB. In addition, the resettlement of displaced population and time lag in reporting on TB cases by the program may account for the apparent decline in 2003. The weather pattern in Sierra Leone is tropical, and divided into two main seasons; the dry and rainy season. The dry season is from November to April and the rainy season is from May to October.

A decline in proportion of PTB ss+ve cases was noted in the third quarter of each year, which comprises the months of July to September, the peak of the rainy season. This suggested an association with tropical seasonal pattern, with more cases of severe chest infections over diagnosed as PTB ss-ve, a higher proportion of PTB cases diagnosed without sputum positive smear confirmation or false positive in the rainy season. This finding did not imply the number of all cases of TB declined during the third quarter. In the literature, evidence supporting variation in infection pattern with different seasons is conflicting and without any clear trend.

A study conducted in a clinic in Malawi, with tropical climate similar to Sierra Leone showed seasonal variations in the pathogens identified in patients with septicaemia and chest infection (Bell *et al.*, 2001). Studies in Spain and Japan showed conflicting findings in the incidence of different

forms of TB in different seasons, which may be explained by local cultural and climatic conditions (Luguero et al., 2005, Nagayama et al., 2006). A study in South East Asia reported findings that TB was more likely to be PTB ss+ve or culture positive in summer season in Hong Kong, which is coherent with this study (Leung et al., 2005).

There are only few publications of studies on evaluation of TB prevention and control activities, with the NLTCP Sierra Leone not being an exception. The conduct of such studies has been a daunting task for some national control programs because of lack of technical expertise, financial and infrastructural resources. A national program review supported by the WHO Global Tuberculosis Program recommends evaluation of national program with the following objectives: to analyse tuberculosis epidemiology, technical policies and programme structure; to evaluate programme activities, underscoring achievements and identify problems; to make recommendations on policy changes and workplan to improve programme effectiveness, at least every 4 to 5 year interval (Pio et al., 1997).

The Donabedian's triad for evaluation of performance of a program was adopted and this included a measure of DOTS expansion and coverage as structure and process indicators, and treatment cure rate, as an outcome indicator (Ader et al., 2001). The main reason this model of healthcare evaluation was used, is that its scope of measurements takes into account all components of healthcare service delivery (structural, process and outcome), and is relatively straightforward to interpret. A study by Rodrigo et al. (2001) demonstrated the usefulness of selecting certain indicators of sub categories of program activities, such as case detection, treatment adherence and follow up, prevention and social support for evaluation of performance of TB control programs. However, some of these indicators may pose challenges of validity and reliability of measurements in a low-income economy country like Sierra Leone with poorly developed health information system (Nolen et al., 2005).

The DOTS expansion in terms of number of DOTS centres established continued to increase over the study period, but fell short of attaining the set target of 70 centre nationwide by 2005. This implied that the objective of nationwide district population coverage of 70,000 population per DOTS centre was not achieved but rather a

coverage of approximately 100,000 population per centre, considering the 2004 population census. On examining each district separately, it was found that district coverage ranged from 41,006 population per DOTS centre (Western area rural) to as high as 234,300 population per DOTS centre (Koinadugu). Furthermore, only four of the fourteen districts actually achieved district coverage of the 70,000 population per DOTS centre.

In terms of treatment cure rate, the WHO target of 85% was achieved by five districts in 2005, compared to only one district in 2002. Though the set target of 85% was not achieved in majority of districts, the improvement in treatment cure rate with improved district DOTS coverage is coherent with findings from studies in countries with similar socioeconomic settings. An evaluation of the TB control program in southern Ethiopia showed that improved DOTS coverage with standard short course chemotherapy identical to the regimen use by NLTCP, resulted in treatment success rate increasing from 38% in 1996 to 74% by 2000 (Shargie and Lindtjorn, 2005). Another study conducted in Malawi showed that effective supervision and community involvement in implementation of the DOTS strategy had a positive impact on performance at the district level (Kelly, 2001). In this study, treatment cure rate increased from 29% to 67% in Mzuzu district, Malawi after such an intervention.

A correlation regression analysis to measure the strength of association between district population DOTS coverage and treatment cure rate in each district gave a correlation coefficient (R = 0.22). This suggested a very weak association between district DOTS coverage and the treatment cure rate. This shows that TB treatment outcome is influenced by a multitude of factors which includes; compliance to treatment regimen, age distribution in the district population and delay in diagnosis of TB, socioeconomic status - urban/ rural poor, access to health care or healthy settings and prevalence of HIV. A study by Nirupa et al. (2005) to evaluate the performance of DOTS providers in Tiruvallur district, India between the periods 1999 to 2002 showed different modes of DOTS providers influenced treatment outcome and the patients experienced different problems in terms of access and compliance which directly impeded on successful outcome. Furthermore, only those with PTB ss+ve were accounted for in treatment cure rate. Other forms of TB cases, PTB ss-ve, EPTB and those

with sputum smear not done were not included in computation. In addition, the validity of the census figures may account for a certain degree of error in the analysis. Nonetheless, certain limitations in the quality of data such as completeness, and validity of data may have influenced the magnitude of these findings. One district, Koinadugu was an outlier in the regression curve but its influence on the strength of association between district coverage and treatment cure rate is minimal.

Limitations of Study

The retrospective study design is reliant on already collected data, which may introduce certain degree of biases and not allow for adjustment of confounding factors. The quality of data collection and recording in the NLTCP as assessed by the checklist was of reasonable quality, however completeness of data recorded in the early period of 2002 was not satisfactory but this improved considerably over the study period. A routine data collection in the health information system of the country was virtually non-existent. Thus, the quarterly trends were based on the data from the NLTCP with no alternative data source to verify its validity and reliability. Other outcome indicators such as defaulter rate, failure rate, etc were not considered in the evaluation. Lastly, an observational study is lower in hierarchy of strength of evidence.

CONCLUSION

The implementation of DOTS expansion by the NLTCP considerably improved DOTS coverage and treatment cure rates in the immediate post conflict period of 2002 to 2005. However, district DOTS coverage showed weak association to treatment cure rates, and its impact on trend of infectious TB notification was limited during this period. Thus, the quality of TB control services needs to be improved. To improve quality, indicators such as access to DOTS services, time to treatment initiation, adherence to DOTS guideline and patient experiences must be evaluated.

It is also very important to ensure TB workers; especially those in DOTS centres in the periphery remain very dedicated and motivated. A basic project implementation cycle; plan → implement → data collection → analysis/evaluation → plan, is fundamental for TB control. Finally, the findings will be useful to TB control and policy but more robust evaluation studies are needed for effective programme implementation.

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