The cost-effectiveness of mobile x-ray screening for tuberculosis in homeless and prison populations in London.

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WORK IN PROGRESS: PLEASE DO NOT CITE. FOR FURTHER INFORMATION, CONTACT JAMES JARRETT

Abstract:

Aims

Tuberculosis (TB) is responsible for approximately 2 million deaths worldwide per year. It is often the marginalised groups, such as homeless and prison populations in which TB still poses serious risks. As these populations are often underserved, it is thought that a mobile x-ray screening unit (MXU) will help find and avert cases of TB. It is therefore the aim of this paper to look at the cost-benefit of such an intervention compared to no screening.

Methods

We have developed a dynamic transmission model to assess the cumulative probability of detecting and averting cases of TB (both multi-drug resistant and non-resistant TB) in the homeless and prison populations of London. A healthcare perspective was taken, including direct costs to the NHS. Indirect costs were not considered. We assumed a 10 year time frame. Treatment outcomes were determined by underlying drug sensitivity. Effectiveness measures were based on cases detected and cases averted from the project in 2005 as well as existing literature. Unit costs and resource use were gathered from national sources as well as the MXU project data.

Data

The data for resource use and costs used in the model was gathered by the MXU team over the initial 18 months of the project (2004-2006). Epidemiological data was modelled by the biostatisticians involved in the project.

Results

At the time of abstract submission, the epidemiological data from the team has not been finalised. Therefore, estimates from the literature were used as proxies for these results. Initial results indicate that the MXU is cost-effective when compared with no screening. It looks as if the MXU is cost-effective if it prevents at least 1 case of TB among either prison or homeless populations.

Conclusions

More detailed analysis of population dynamics of the homeless and prison populations must be carried out. However, it seems that using the MXU is a valid method of both case finding in these marginal populations as well as preventing further cases.

Introduction:

Tuberculosis (TB) is an infectious disease which predominately affects the lungs. It is caused by *Mycobacterium tuberculosis* and is treated by an intense course of antibiotics. Within England, the infection rates have been relatively stable in the last 20 years, but there is large geographical variation and a marked increase in the major cities. For example, in London, there were 38 new cases per 100,000 population in 2001, compared with less than five in the south west of England, with large differences even between the London boroughs (1).

In 2002, a working group of the World Health Organisation (WHO), International Union Against Tuberculosis and Lung Disease (IUATLD), and the Royal Netherlands Tuberculosis Association (KNCV) advocated a broad spectrum of interventions for low-incidence countries. Among these, a general approach ensuring rapid detection and treatment of all cases and preventing deaths as well as a control strategy aimed at reducing the incidence of TB within high-risk groups.(2)

As part of the TB control strategy within England, the UK Department of Health is funding a pilot programme of active case finding for pulmonary TB amongst high risk groups. Over a two-year period, a state of the art mobile digital X-Ray unit (MXU) will be used to outreach low dose chest radiography to those groups known to be at highest risk from TB. Although risk factors for TB are inter-related and complex, it is thought that high-risk groups such as homeless, prison and new entrants from areas with high latent TB and HIV infection rates. Within London, these populations are not necessarily distinct from one another. It is thought that by identifying cases of tuberculosis earlier than through existing service arrangements, active case finding has the potential to reduce onward transmission, severity of disease and consequent use of health service resources. Indeed, in the Netherlands, TB control experts have found that discontinuing screening in high-risk groups sometimes leads to ongoing transmission for years before it becomes visible. They advocate the use of mobile x-ray units with digital equipment to deal with these high-risk groups. (3) This paper is part of the wider evaluation of the pilot programme and its aim is to analyse the cost effectiveness of MXU when compared to no screening.

Methods

We developed a population transmission dynamic model to assess the cumulative probability of detecting and averting cases of TB (both multi-drug resistant and non-resistant TB) in the homeless and prison populations of London. The perspective of the model is that of the NHS. The project pilot period is two years; however, we have extended the analysis to 10 years in order to look at longer term impacts of using the MXU. We assumed that the MXU would run at full capacity and that the goal would be to screen every person twice a year (6 month intervals).

Resource Use:

All healthcare resources were assessed, including all contacts with the MXU and subsequent referrals and hospitalisations. Information on the resource use of the MXU and subsequent healthcare use is reported separately. Data on resource use was taken from the records of the MXU. It is assumed that treatment outcomes were determined by underlying drug sensitivity. We assumed those patients diagnosed with TB or MDR-TB were treated using national guidelines. (4) As it is common in this population to be "lost" once a referral is made from the MXU, this was factored into our analysis.

Unit Costs:

Unit costs were gathered from national sources (5,6,7) and MXU project data in the first instance. We are in the process of gathering unit costs from several key treatment sites around London. It is felt this will be a more accurate reflection of the cost of treatment/hospitalisations. Total costs were calculated by multiplying each patient's resource use by the unit costs. All costs were adjusted to reflect 2006 prices.

Outcomes:

The outcomes of effectiveness for this study are cases of pulmonary TB found and averted. Effectiveness measures in this version of the paper were based on cases detected and cases averted from the project in 2005 as well as existing literature (1). We are currently awaiting the mathematical model results which we hope will better inform these key parameters.

Model:

We developed a population transmission dynamic model in order to account for the complexity of the problem. The initial model in this paper is very simplified as we are awaiting information from the project team to carry out the full analysis.

Table 1 gives a list of parameters used for the model. We assumed a population size of 20000 (10000 prisoners, 10000 homeless). We also assumed the epidemiology within these groups is the same. Again, this will be investigated further when the data is available from the mathematical modellers. From a forthcoming study by Story, et al (1) on these populations we used a starting prevalence of 30%. We assumed the risk of transmission is equal to the risk of transmission when in contact with infected person x number of contacts per transition period x prevalence. We assumed that everyone came into contact with 10 others in the population every 6 months time period and that the risk of infection was 1%.(REF) For simplicity, we also assumed that the survival rate was 100% and that influence from co-morbidities (such as HIV/AIDS) is nil. From existing project data we extrapolated that the sensitivity and specificity of the MXU was 30%.

Table 1: Author Assumptions (from literature or project data)

Starting population:	20000
Starting prevalence of TB:	0.03
Risk of transmission from contact:	0.01
Number of contacts per person per six months:	10
Sensitivity of screening test:	0.3
Specificity of screening test:	0.3
Number screened per transition period:	10000
Treatment cure rate:	0.75
Cost per screen:	13.32
Cost per treatment:	64289

Once a person was “found” in either arm, we assumed they underwent treatment (in the MXU arm, cost of screening was also included in total cost per patient). Although the population in question would most likely benefit from directly observed therapy (DOTS), the project team has found that most confirmed TB cases in this population are not put onto DOTS. Therefore, standard self administered treatment was assumed. This consists of a 6 month course of antibiotics. From project data, we placed an efficacy rate on treatment at 75% to reflect the cases of MDR TB as well as people who for one reason or another are not followed up. Those patients within the 25% may be able to infect others within the population groups. We assumed those on treatment would not be infectious to others in the population as standard treatment would place them in isolation wards.

Sensitivity analysis

We will carry out two way sensitivity analysis when the mathematical modellers input their data into the model.

Results

Initial results indicate that screening using an MXU is favourable when compared to not screening at all. Table 2 gives the initial model results. We found that after one year of running, the MXU begins to become more cost effective in terms of both cases detected and cases averted. In the longer term, it also becomes much cheaper than a “do nothing” option.

Discussions/conclusions

While this is a work in progress and a very simplified model of the cost-effectiveness of using a MXU to screen for TB in homeless and prison populations, it seems that the MXU dominates the do nothing option after only 2 rounds of screening. However, we have made some strong assumptions and more analysis must be undertaken.

In reality, the situation is much more complicated than presented here. The services into which screened (or unscreened for that matter) homeless and prison people would be sent to are of variable quality and people often get “lost” between the referral from the van to the hospital. The project has hired an outreach nurse to try physically get the person from the van to the hospital and into care. It is hoped this will increase the number of patients staying in treatment, and therefore decrease the number of new infections.

In our model, we assumed that there were no co-morbidities affecting the individuals. Again, reality is much more complex. The populations we’re studying are often heavy drug users and also have a higher risk of being immuno-compromised. Leaving the co-morbidities out of our study doesn’t necessarily effect the usefulness of the service, as it could be argued that once referred to the hospital or clinic for TB, other diseases may be found and therefore it could be of extra benefit to the patient (and cost to the NHS).

We have worked to find the correct model structure and after attempting markov analysis, it became clear that it was not the best tool for the job. The population transmission dynamic model has proved useful in that it allows populations to interact more freely. Any comments on alternatives or improvements to this model would be most welcomed.

References

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4. National Collaborating Centre for Chronic Conditions. Tuberculosis: clinical diagnosis and management of tuberculosis, and measures for its prevention and control. London: Royal College of Physicians, 2006.
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6. PSSRU. Unit Costs. 2005.
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Table 2: Initial Results of Transmission Dynamic Model of MXU vs. No Screening for Tuberculosis in Homeless and Prison Populations

	No MXU				MXU						
Period	Cases of TB	Prevalence	Cases detected	Cost	Cases of TB	Prevalence	Cases detected	Cost	Cases Averted	Difference in Cases Detected	Difference in Cost
0	543	0.03	108.6	£6,981,785	574	0.03	114.8	£7,380,377	-31	-6	-£398,592
1	600	0.03	120	£7,714,680	636	0.03	127.2	£8,177,561	-36	-7	-£462,881
2	656	0.03	131.2	£8,434,717	655	0.03	131	£8,421,859	1	0	£12,858
3	735	0.04	147	£9,450,483	655	0.03	131	£8,421,859	80	16	£1,028,624
4	798	0.04	159.6	£10,260,524	663	0.03	132.6	£8,524,721	135	27	£1,735,803
5	869	0.04	173.8	£11,173,428	695	0.03	139	£8,936,171	174	35	£2,237,257
6	958	0.05	191.6	£12,317,772	717	0.04	143.4	£9,219,043	241	48	£3,098,730
7	1047	0.05	209.4	£13,462,117	729	0.04	145.8	£9,373,336	318	64	£4,088,780
8	1147	0.06	229.4	£14,747,897	761	0.04	152.2	£9,784,786	386	77	£4,963,111
9	1254	0.06	250.8	£16,123,681	809	0.04	161.8	£10,401,960	445	89	£5,721,721
10	1355	0.07	271	£17,422,319	849	0.04	169.8	£10,916,272	506	101	£6,506,047
11	1482	0.07	296.4	£19,055,260	884	0.04	176.8	£11,366,295	598	120	£7,688,964
12	1615	0.08	323	£20,765,347	940	0.05	188	£12,086,332	675	135	£8,679,015
13	1768	0.09	353.6	£22,732,590	979	0.05	195.8	£12,587,786	789	158	£10,144,804
14	1944	0.10	388.8	£24,995,563	1030	0.05	206	£13,243,534	914	183	£11,752,029
15	2115	0.11	423	£27,194,247	1104	0.06	220.8	£14,195,011	1011	202	£12,999,236
16	2273	0.11	454.6	£29,225,779	1154	0.06	230.8	£14,837,901	1119	224	£14,387,878
17	2475	0.12	495	£31,823,055	1199	0.06	239.8	£15,416,502	1276	255	£16,406,553
18	2722	0.14	544.4	£34,998,932	1292	0.06	258.4	£16,612,278	1430	286	£18,386,654
19	2939	0.15	587.8	£37,789,074	1385	0.07	277	£17,808,053	1554	311	£19,981,021
Mean	1464.75	0.07	292.95	£18,833,463	885.50	0.04	177.10	£11,385,582	579.25	115.85	£7,447,881
Standard Dev	738.69	0.04	147.74	£9,497,903	239.78	0.01	47.96	£3,082,999	499.59	99.92	£6,423,640
Confidence (95%)	10.36	0.00	2.07	£133,176	3.36	0.00	0.67	£43,229	7.01	1.40	£90,070