Explanation of incentives for immunization CEA inputs

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How much does the intervention cost per child targeted?

Bottom-line

The best guess input for cost per child under two targeted by the camps-only intervention is approximately $3, and for the camps and incentives is approximately $6, with a range of $1-$6 for the camps-only intervention, and $4-$11 for the incentives intervention.

Key judgement calls and sources of variability

1. **Cost perspective.** There are different ways to model the cost of the intervention: Either from the perspective of what a government would pay to implement the intervention, what a charity would pay to implement the intervention, or what a technical assistance charity would pay to persuade/help government to implement the intervention. For the best guess input I've used the perspective of a charity implementing the intervention.

2. **Exclusion of cost of vaccines.** In the RCT the vaccines were not included in the costs of the camps since the government paid for vaccines. In the best guess estimate here I've continued to exclude the cost of vaccines, with the assumption that government would continue to pay for vaccines.

3. **A different program might use money more or less efficiently.** For a future charity implementing the same intervention, they may run the same intervention at a higher or lower cost.

4. **The RCT was conducted in a particularly rural environment.** The RCT was conducted in a rural environment, which might make the intervention more expensive. This is because camps have a relatively fixed cost, so if more

children are able to access the same camp (i.e., in a more populated area) then the cost per child is lower.

5. **It difficult to model how many children each camp targets.** In particular modelling from the camps-only intervention (done for the best guess) is more conservative than from the incentives intervention. I've done this because there was significant spill-over in the incentives intervention where people from neighbouring villages came to the camps, which increased the number of people the intervention was available to: For a wider scale intervention I believe that this effect would be diminished.

Best guess input

If we model from the camps-only section of the RCT to calculate costs of running the camps per child under two targeted, we get about $3 per child under two targeted by the camps (see estimate details at the bottom of the document).

For the camps and incentives intervention, we include the cost of incentives: around $1 per vaccine and $2 for completed set of vaccinations[1]. Assuming that the average child receives roughly three vaccines, and around 40% of children receive a full set of vaccinations,[2] the cost for camps and incentives would be roughly $6.

Range

Lower bound: We could optimistically assume that each camp will treat twice as many people than in the best guess scenario, due to changes in population density and the number of people who want to use the camps. We could also assume that a charity runs the intervention 50% more cost-efficiently. Then the camps-only intervention would cost around $1 per person targeted (3 / (2 * 1.5)), and the camps with incentives intervention would cost around $4 per person targeted ($1 cost of camp plus the same $3 cost of incentives as previously).

Upper bound: We could assume that each camp will target the same number of people (it probably will not treat fewer, since the location is already very rural), and the charity runs the intervention 50% less efficiently. Additionally we could assume

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[1] "The only costs affected by the number of children attending the camps and therefore included in marginal costs are the honorarium of $0.26 per child paid to the village workers for mobilizing children for the camps and the actual incentives paid to the parents for 2 immunizing their children ($0.91 per kilogram of lentil and $1.70 per thali set)" Appendix 2, Pg. 1

[2] In the RCT, the average number of vaccines given in the incentives intervention was 2.85, but this would probably be higher in less rural environments (the average number of vaccines given to children is unusually low in the environment where the RCT was conducted): "According to the National Family Health survey (NFHS-3), in India only 44% of children aged 1-2 years have received the basic package.6 That drops to 22% in rural Rajasthan, the setting of the present study, and was less than 2% in our study area (a disadvantaged population in rural Udaipur) at baseline (according to a more detailed survey instrument than the NFHS-3, that was less likely to overestimate full immunisation rates)." RCT, Pg. 1

that incentives are 50% more expensive, without additional benefit. Then the cost per person targeted by a camp would be $6 and the cost for the camps with incentives would be ~$11.

Further work we could do on this input

Have a second person check the logic, judgement calls, and calculations for a second perspective.

What percentage of the children targeted by the intervention receive vaccines, who otherwise would not receive vaccines?

Bottom-line

- In a future **camps-only** intervention, roughly 15%-25% of children would receive a measles vaccine, the DPT vaccines, and a BCG vaccine, who otherwise would not receive these vaccines. Lower bound of 8%-15%, upper bound of 20%-35%.
- In a future **camps and incentives** intervention, roughly 25%-40% of children would receive a measles vaccine, the DPT vaccines, and a BCG vaccine, who otherwise would not receive these vaccines. Lower bound of 10%-20%, upper bound of 30%-50%.

Key judgement calls and sources of variability.

1. **Location that charity works in.** The RCT was conducted in a very rural area with unusual poor health. This meant that baseline vaccination levels were extremely low.[3] Reported levels of vaccination countrywide in India or Pakistan (suggested areas for the intervention) are much higher.[4] For the best guess, I have modelled baseline vaccination rates as similar to the RCT, but allowed an option to modeled as halfway between the RCT baseline rates and the national average.

2. **Little evidence to draw from.** The numbers are based from one RCT, and the RCT itself doesn't paint an entirely coherent picture. For instance, the RCT reports that children in the camps and incentives intervention receive on average 0.5 more vaccines than in the camps-only intervention,[5] and that 39% of children are fully vaccinated in the camps and incentives intervention, as opposed to 18% in the camps-only intervention.[6] However when judging by presence of a scar left from a BCG vaccination, both groups show the same proportion of scars.[7] This made me little concerned about over-reporting in the camps and interventions group, though the authors of the RCT did investigate this (I have not looked into the issue in detail). For the best guess, I have kept

[3] ""According to the National Family Health survey (NFHS-3), in India only 44% of children aged 1-2 years have received the basic package. That drops to 22% in rural Rajasthan, the setting of the present study, and was less than 2% in our study area (a disadvantaged population in rural Udaipur) at baseline (according to a more detailed survey instrument than the NFHS-3, that was less likely to overestimate full immunisation rates)." RCT, Pg. 1 http://www.povertyactionlab.org/publication/improving-immunization-coverage-rural-india-evaluation-immunization-campaigns-and-withou

[4] As reported by UNICEF and WHO.

[5] Table 2, page 6 of the RCT

[6] "Results Among children aged 1-3 in the end point survey, rates of full immunisation were 39% (148/382, 95% confidence interval 30% to 47%) for intervention B villages (reliable immunisation with incentives), 18% (68/379, 11% to 23%) for intervention A villages (reliable immunisation without incentives), and 6% (50/860, 3% to 9%) for control villages." Pg 1, RCT.

[7] Table 2, page 6 of the RCT

the BCG increase constant between camps-only and camps and incentives, to model the results found in the RCT.

3. **The RCT didn't measure by individual vaccines.** The RCT measured by metrics such as 'received more than one vaccine' and 'was fully vaccinated', but didn't report on which vaccines in particular were received. This makes quite a lot of difference to cost-effectiveness, since some vaccines are more useful than others. Information to model by individual vaccine is included in the attached excel file.

4. **Polio is excluded from these calculations.** I've excluded the polio vaccinations from these calculations for two reasons: The RCT excluded polio vaccinations from its definition of 'fully immunized' because almost all children already receive a polio vaccination,[8] and also because polio is now very rare, and doesn't affect cost-effectiveness much at all.

5. **A future charity might focus on different vaccines.** Vaccines considered here are a measles vaccine, a tuberculosis vaccine, and three doses of DPT. This could be different for a future intervention.

Best guess input

To calculate the best guess input:

1. Coverage rates from the RCT in both the control and intervention groups are broken down into individual vaccines, using the attached excel spreadsheet. These estimates are rough.
2. Baseline coverage for future interventions is assumed to be the same as the control group in the RCT. There is an option to chance baseline coverage to halfway between the control group coverage for the RCT, and the reported national coverage in India and Pakistan.
3. If using the option to model baseline coverage as halfway between the control group in the RCT and reported national coverage, the future intervention is assumed to decrease the number of unvaccinated children (broken down into each individual vaccine) by the same proportion as in the RCT. So if the RCT increased coverage of a vaccine from 30% to 65%, a future intervention with baseline coverage of 70% would be assumed to increase coverage to 85%.

Using this method:

- In the **camps-only** intervention, roughly 15%-25% of children would receive a measles vaccine, the DPT vaccines, and a BCG vaccine, who otherwise would not receive these vaccines.

[8] "The outcomes include the probability of receiving at least one immunisation (excluding oral polio vaccine, which almost all children have received and therefore does not affect the statistics); the presence of the BCG scar; the number of immunisations received; and the probability of receiving the complete extended package of immunisation." RCT Pg. 4

- In the **camps and incentives** intervention, roughly 25%-40% of children would receive a measles vaccine, the DPT vaccines, and a BCG vaccine, who otherwise would not receive these vaccines.

Range

Lower bound
If we assume that future baseline coverage rates will be halfway between those of the control group in the RCT and the reported coverage rates of India and Pakistan, and that due to over-reporting the RCT vaccine increase statistics are 25% optimistic, then:

- In the **camps-only** intervention, roughly 8%-15% of children would receive a measles vaccine, the DPT vaccines, and a BCG vaccine, who otherwise would not receive these vaccines.
- In the **camps and incentives** intervention, roughly 10%-20% of children would receive a measles vaccine, the DPT vaccines, and a BCG vaccine, who otherwise would not receive these vaccines.

Upper bound
If we assume that coverage rates will be equal to the RCT, and that a future campaign is conducted 25% more effectively (perhaps due to trial and error with advocacy and camp promotion, or general improvement over time) then:

- In the **camps-only** intervention, roughly 20%-35% of children would receive a measles vaccine, the DPT vaccines, and a BCG vaccine, who otherwise would not receive these vaccines.
- In the **camps and incentives** intervention, roughly 30%-50% of children would receive a measles vaccine, the DPT vaccines, and a BCG vaccine, who otherwise would not receive these vaccines.

Further work we could do on this input

1. Vet the excel spreadsheet attached, or spend more time getting the breakdown in the spreadsheet right.
2. Vet the assumed coverage rates.
3. Vet the logic and judgement calls in this document.

Efficacy of vaccines

Bottom-line

The efficacy of the vaccines described is not the initial efficacy, but the percentage chance that a vaccinated person is immunized at the point at which they are exposed to the disease (relevant since immunization frequently diminishes over time). Given that, the best guess for efficacy is:

- **Tuberculosis vaccine**: 14%
- **Measles vaccine**: 88%
- **Pertussis**: 33% efficacy with DPT1, 69% with DPT2, and 76% with DPT3.
- **Tetanus**: 42% efficacy with DPT1, 67% efficacy with DPT2, and 76% efficacy with DPT3.

Key judgement calls and sources of variability

1. **What is the initial efficacy of the vaccine?** Some vaccines, especially BCG that vaccinates against Tuberculosis (a key driver of cost-effectiveness), have very variable efficacy. This is partly due to prior exposure to the disease: In areas where people have already been exposed to Tuberculosis, efficacy is much lower.[9] I've used the initial efficacies given in the IDinsight CEA, since they seemed to match with briefly reading around the topic online. However the BCG efficacy in particular could be modelled differently and can change the overall cost-effectiveness estimates significantly.

2. **How long does the vaccine last?** Most vaccines are thought to become less effective over time, but the rate at which they become less effective is

[9] "BCG vaccine has been the subject of numerous efficacy trials and epidemiological studies conducted over several decades. These trials indicate that BCG has 60-80% protective efficacy against severe forms of tuberculosis in children, particularly meningitis,[1] [2] and its efficacy against pulmonary diseases varies geographically.[3] [4] [5] BCG does not seem to protect against disease when it is given to people already infected or sensitised to environmental mycobacteria, which could explain the geographical variation.[6] [7] [8]" Effect of BCG vaccination against *Mycobacterium tuberculosis*infection in children: systematic review and meta-analysis. http://www.bmj.com/content/349/bmj.g4643

unclear. Since for this intervention infants are being vaccinated, for diseases that are generally caught at an older age (such as Tuberculosis), this factor is very important: If efficacy has completely diminished by adulthood then a BCG vaccine as an infant is not very useful. However if efficacy diminishes slowly and lasts somewhat into adulthood, a BCG vaccine as an infant is still very useful because of the high prevalence of Tuberculosis. The IDinsight CEA uses sharp cut-offs for vaccine efficacy: the vaccine efficacy drops to zero at a particular point in time. I found this to be unrealistic,[10] and after looking briefly into the sources they used and reading briefly around the topic, decided to introduce a gradual cut-off, where at each subsequent five-year age period, the previous efficacy reduces by a factor of 0.75. **This is very rough because different vaccines will decrease at different rates: More research could make this number more accurate.**

Best guess input

The best guess input uses the method of calculation in the IDinsight CEA, with altered cut-offs for vaccine efficacy over time (as described above) and altered disease prevalence across age groups to take into account that prevalence will probably decline over time. To calculated declining prevalence I used GapMinder[11], and looked at the average decrease of existing cases of Tuberculosis in India and Pakistan over a 10 year period from 1995 to 2005, and assumed this rate of decrease to continue, and generalize to other diseases.[12]

The IDinsight CEA then compares the years in which a person is likely to be immunized against a disease to the years in which a person is likely to contract the disease, to calculate the lifetime efficacy: i.e., how likely is a person to be

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[10] In particular the CEA seemed to use the amount of time after which a person is recommended to get a booster if they are exposed to a disease (i.e., "if someone has been cut by a rusty piece of metal and ten years have passed since they received a Tetanus shot, it is recommended that they receive another Tetanus shot") as a guide for when to drop efficacy to zero. I assume that the recommendations for when to get a booster are not equivalent to the time at which a vaccine is 0% effective, but rather when its percentage chance of being effective is low enough that it's worth getting a booster.

[11] http://www.gapminder.org/world/#$majorMode=chart$is;shi=t;ly=2003;lb=f;il=t;fs=11;al=30;stl=t;st=t;nsl=t;se=t$wst;tts=C$ts;sp=5.59290322580644;ti=2007$zpv;v=0$inc_x;mmid=XCOORDS;iid=ti;by=ind$inc_y;mmid=YCOORDS;iid=rZNoyaocUmUGuFyRgjJUpig;by=ind$inc_s;uniValue=8.21;iid=phAwcNAVuyj0XOoBL_n5tAQ;by=ind$inc_c;uniValue=255;gid=CATID0;by=grp$map_x;scale=lin;dataMin=1990;dataMax=2007$map_y;scale=lin;dataMin=0;dataMax=1485$map_s;sma=49;smi=2.65$cd;bd=0$inds=i101_t001996,,,,;i170_t001996,,,,

[12] India had 525 new cases per 100,000 people in 1995, and 299 per 100,000 people in 2005. Pakistan had 422 new cases per 100,000 people in 1995, and 299 per 100,000 in 2005. From this I estimated a decrease of around a factor of 0.8 every five years (the relevant time period for the IDinsight CEA).

immunized against the disease at the time when they might contract it, given that they were given a vaccine as an infant.

My calculations of the numbers are in the attached excel file, under the sheet 'Epidemiology', in the section 'Probability of protection over a lifetime', cells J3 to L9.

Range

Ranges are calculated for Tuberculosis and Measles only, since they drive the cost-effectiveness.

Lower bound:

Assuming more conservative estimates for efficacy (guessed after briefly reading about the vaccines) and the sharp cut-offs introduced by the IDinsight CEA:

- **Tuberculosis vaccine**: 0.6% (using initial 10% efficacy)
- **Measles vaccine**: 50% (using initial 80% efficacy)

Upper bound:

Assuming more generous estimates for efficacy (guessed after briefly reading around the vaccines) and a factor of 0.9x instead of 0.75x reduction in efficacy every five years:

- **Tuberculosis vaccine**: 28% (using initial 70% efficacy)
- **Measles vaccine**: 90% (using initial 95% efficacy)

Process

I considered the inputs and calculations of the IDinsight CEA and the JPAL CEA, and did some reading around the topic online. I looked into the sources of the JPAL CEA and the IDinsight CEA to see if they seemed sensible. I found the initial efficacy estimates of the IDinsight CEA to look sensible, but I have not vetted them carefully. I also haven't vetted the age distribution of disease prevalence that is used for the IDinsight CEA calculations, though I quickly checked online to see if it seemed reasonable.

Further work we could do on this input

1. Investigate the efficacy of BCG further, since this number is crucial to the overall estimates.
2. Investigate how long lasting the efficacy of the vaccines is, and what an appropriate factor would be to decrease efficacy over time, incorporating the fact that this may be different for different vaccines.

3. Vet the lifetime distribution of the diseases as presented by IDinsight, and get a more accurate picture of the decrease in prevalence over time.
4. Vet the initial efficacy of the vaccines as presented by IDinsight.

Chance of contracting a disease over the course of a lifetime if unimmunized

Bottom-line

This input measures the chance that an infant who is not immunized against the disease will contract the disease over the course of their lifetime. This takes into account that disease incidence falls over time (and in some cases falls quickly) so the chance of contracting the disease over a lifetime is significantly lower than if incidence rates remained constant. Given that, the best guess for chance of contracting a disease over the course of a lifetime if unimmunized is:

- **Tuberculosis**: 4% (range 0.36% to 8.48%)
- **Measles**: 4% (range 2.71% to 11.56%)
- **Pertussis**: 2% (range 1.25% to 4.6%)
- **Tetanus**: 0.06% (range 0.04% to 0.36%)

Diphtheria is excluded since the mortality burden from diphtheria was low enough to be reasonably negligible. However this may be because burden from diphtheria is not reported directly, but through complications of the disease: this could be included at a later date. Neonatal tetanus is also excluded since Tetanus vaccinations tend to be given at a time after neonatal tetanus is contracted.[13]

Key judgement calls and sources of variability

1. **Input for taking into account a rural environment.** Incidence is calculated using statistics given for averaged national averages from Pakistan and India. However the incidence in areas where a future charity might focus will probably be higher due to less access to health care in rural environments. On the attached spreadsheet, the input on the Summary table in cell E25 allows an adjustment for this.

2. **Method of calculating estimated incidence rates.** Incidence of a disease for one particular year is calculated by taking the number of deaths from the disease in that year divided by the case fatality rate. This is because estimated incidence rates are difficult to find and vary widely, and reported incidence rates are assumed to be much lower than actual incidence. As a sanity check, the attached spreadsheet estimates the factors of under-reporting for Measles, Pertussis, and Tetanus, which come to ~45x, ~500x, and ~10x. Noting this, the Tetanus estimate may be low, and the Pertussis estimate may be high; though since Tetanus is a much more serious disease than Pertussis, it is also possible that people who contract Tetanus are much more likely to go to hospital, resulting in higher reporting rates.

[13] In future estimates, neonatal tetanus could be included by considering increased rates in mothers and the subsequent decreased probability of an infant contracting neonatal tetanus. This will probably not move the bottom line a large amount due to quickly falling neonatal tetanus rates.

3. **Source of mortality burden rates.** Mortality rates are taken from http://vizhub.healthdata.org/gbd-compare/, with some sanity checking. Vizhub may not be very accurate: numbers are taken from here because this source had the most recent numbers (and numbers over many years), and incidence is falling quickly for almost all diseases. This is worth bearing in mind if checking this input against other papers / estimates.

4. **Rate of incidence decline.** The prevalence of most diseases is declining relatively quickly, with variation by location and by disease. The amount by which a disease declines affects cost-effectiveness significantly, especially for diseases that are most likely to be caught in middle age. For the best guess, I have used rates of decline modelled from an average of the rate of decline for Pakistan and India from 1990 to 2013.[14] However this does not take into account that some of this decline is probably attributed to a declining case fatality rate, as well as declining incidence. After preliminary reading about the topic, it seemed that incidence was falling significantly faster than CFR, so the approximation may not make a large difference, but it could be incorporated at a later date.

5. **The effect of not being immunized**. The risk of death from a disease is higher if a person is unimmunized than from the general population, but it's tricky to see how much higher. To calculate this, I assume that all incidence in a particular age group comes from the proportion of that age group that is unimmunized (using immunized to mean unable to contract the disease, not just vaccinated against the disease), and use the ratio of (incidence in age group / people in age group that are unimmunized) to calculate the incidence in the age group given that a person is not immunized.

Best guess input

The best guess inputs are calculated on the attached spreadsheet in sheets 'New cases in a year' and 'Epidemiology'. The chance of contracting a disease over the course of a lifetime if unimmunized is calculated as follows:

1. The percentage of deaths attributable to a disease is taken from http://vizhub.healthdata.org/gbd-compare/ and averaged for Pakistan and India.
2. The risk of death from a particular disease in one year is calculated by multiplying the above by the overall risk of death in a year averaged from Pakistan and India.
3. The risk of death from a particular disease in one year is divided by the case fatality rate to obtain the incidence in a population for one year (modelled for the population of Pakistan, though for modelling purposes, not to affect the outcome).

[14] http://vizhub.healthdata.org/gbd-compare/

4. Incidence among the population is calculated for future years using an averaged incidence decline rate.
5. The total incidence each year is divided up amongst age groups, using age-breakdowns of disease prevalence, and taking into account rates of immunization in different age groups.

Range:

Lower bound:
We could assume that tuberculosis starts decreasing at the same rate as other diseases, due to increased resources devoted to this disease. We could also assume that incidence is not increased in rural areas. This gives us an overall estimate of:

- **Tuberculosis**: 0.36%
- **Measles**: 2.71%
- **Pertussis**: 1.25%.
- **Tetanus**: 0.04%.

Upper bound:
We could assume that rates of decline in disease level off to 0.98, and that incidence in rural areas in twice as high as the national average. This would give estimates of:

- **Tuberculosis**: 8.48%
- **Measles**: 11.56%
- **Pertussis**: 4.6%.
- **Tetanus**: 0.36%.

Further work we could do on this input

Have a second person check the logic, judgement calls, and calculations for a second perspective.

Invest more time into researching which sources to use for mortality data, and for decline in incidence.

Investigate the extent to which a rural environment affects incidence rates.

Case fatality ratio

Bottom-line
The best guess for mortality is:

- **Tuberculosis**: 18.2% (range 10% to 60%)
- **Measles**: 2.79% (range 1% to 4%)
- **Pertussis**: 3% (range 2% to 4%)
- **Tetanus**: 41.1% (range 15% to 80%)

Key judgement calls and sources of variability

1. **CFR in rural environment.** The source that the Measles CFR estimate comes from notes that CFR in rural environments is significantly higher than the overall CFR.[15] The best guess input for Tetanus and TB come from national averages in India or Pakistan, and so adjusts to take into account a more rural environment using the ratio from this source of the median CFR in rural environments to the median CFR overall (2.79/1.63 = 1.71).[16]

2. **CFR decreases over time.** Case fatality rate decreases over time[17], but this is not currently taken into account either for the current estimate of CFR (it may be lower than calculated, since studies are conducted in the past), or for future estimates of CFR. This does not largely affect the overall cost per death-averted estimate, since this primarily uses a decreasing mortality burden over time, which is presumably caused by both decreasing incidence and decreasing CFR. If morbidity were added to the CEA at a later date then this factor could be more important.

3. **CFR for Tetanus is rough.** The case fatality rate for tetanus depends a lot on how many people seek treatment, and on case fatality rate for the untreated. I didn't find a good source for the latter, and used an approximate estimate from the former, based on how many people seek treatment for tuberculosis.

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15 "The CFRs for studies conducted in rural communities (median=2.79, Q1=0.20 and Q3=7.00) were significantly higher in comparison to urban studies (median=0.00, Q1=0.00 and Q3=0.00) (P=0.015)." P 984 http://www.indianpediatrics.net/nov2009/983.pdf

16 "The median CFR was 1.63 per 100 cases (Q1= 0.00 and Q3= 5.06)." Pg 1 http://www.indianpediatrics.net/nov2009/983.pdf , compared to median in the footnote above.

17 An example for the measles source: "Studies conducted after 1994 had significantly lower CFRs (P=0.031). Studies in rural settings had significantly higher CFRs compared to urban studies (P=0.015)." http://www.indianpediatrics.net/nov2009/983.pdf

Best guess input

- **Tuberculosis**: 18.8%

From the WHO,[18] in India in 2015 220,000 deaths are attributed to TB and 31,000 attributed to TB though reported as HIV deaths, with an incidence of 2,200,000. In Pakistan in 2015 48,000 deaths are attributed to TB and 1500 are attributed to TB but reported as HIV deaths, with an incidence of 500,000. So the implied CFR for India is (220+31)/2200=11.4%, the implied CFR for Pakistan is (48+1.5)/500=9.9%, with an average of (11.4+9.9)/2 = 10.65%. This is then multiplied by the factor to adjust for a rural environment (discussed above).

- **Measles**: 2.79%

Taken from the median CFR for studies conducted in rural environment in India, from the source http://www.indianpediatrics.net/nov2009/983.pdf

- **Pertussis**: 3%

Taken from the case fatality rate from an outbreak in a rural part of Papua New Guinea.[19]

- **Tetanus**: 41.1%

CFR with treatment is taken as 0.1[20] and without treatment is taken as 0.8 (estimated after reading about the topic). The probability of seeking treatment is modelled as the same as the probability for seeking treatment for TB in India (~0.8)[21]. Thus the overall estimated CFR is ~= (0.8 * 0.1 + 0.2 * 0.8) = 0.24. This is then adjusted by the adjustment for rural environments (discussed above).

Range

Lower bound:

Rough estimate from reading around the topic:

- **Tuberculosis**: 10% (Most all in community have access to treatment)
- **Measles**: 1% (National average, adjusted downwards for falling CFR since time of studies)
- **Pertussis**: 2%
- **Tetanus**: 15% (Most all in community have access to treatment)

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18 http://apps.who.int/iris/bitstream/10665/191102/1/9789241565059_eng.pdf?ua=1, all figures on page 14

19 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3729097/

20 WHO (2006)

21 Kaulagekar and Radkar (2007). Social status makes a difference: Tuberculosis scenario during NFHS-2

Upper bound:

Rough estimate from reading around the topic:

- **Tuberculosis**: 60% (Most all in community do not have access to treatment)
- **Measles**: 4% (high assumption)
- **Pertussis**: 4% (estimated case fatality for infants)
- **Tetanus**: 80% (Most all in community do not have access to treatment)

Further work we could do on this input

1. Spend more time finding appropriate sources for data, and thinking about how they apply to the context of the intervention.
2. Spend more time investigating the ranges.