

BURDEN OF DISEASE CALCULATION, COST OF ILLNESS ANALYSIS AND DEMAND FOR DEATH: A THEORETICAL REVIEW

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Abstract

The works of Murray and co-workers on calculating Burden of Disease (BoD), and even the analysis of Cost of Illness (CoI), to fully understand the priority areas for public health intervention, have sparked controversies in health economics. This paper joins in these controversies. It brings together the methodologies for BoD calculation; Disability Adjusted Life Years (DALY), which is Years of Life Lost (YLL) + Years of Life Lived in Disability (YLD), as well as analyzes the CoI; Direct Health Care Cost (DHC), Direct Non Health Cost (DNHC), Indirect Non Health Care Cost (INHC), Indirect Health Care Cost (IHC). Added to the criticisms found in literature, the paper posits reasons why BoD calculation and CoI analysis may even prove to be more difficult with diseases of the tropic regions in developing countries. There are data unavailable and unlike the diseases of the temperate regions, which are less prevalent and thus easy to quarantine, diseases of the tropic regions are usually of high prevalence, making quarantine impossible and making the exercise very expensive. The paper introduces the demand for death for Activities of Daily Living (ADL) measured disability as being pioneered by Igberaese and co-workers, as a way of eliminating the BoD and CoI once and for all. It makes DALY only equal to YLL, as YLD approaches zero. DALY will simply be the number of years of life lost due to mortality. It has removed the entire burden that he and the relatives, including that of his caregiver would have suffered if he had not died, but continued to live in the state of ADL disability. Demand for death also enlarges IHC, which is the future savings on health care cost as a result of premature death. DHC approaches zero, DNHC also approaches zero while INHC remains constant. This is also a great gain, as the individual's relatives and the society can channel such resources and energy to other uses that would benefit the household and the economy.

Keywords: Burden of disease calculation, Cost of illness, Demand for death, Disability adjustment life.

Introduction

Since the works of Murray and co-workers about two decades ago, calculating the Burden of Disease (BoD), and Oostenbrink, Bouwtmans, Koopmanchap and Rutten (2004), analysis of the Cost of Illness (CoI) have become a concern and heated debate among health economists for the selection of the important areas to be focused in public health intervention (Murray and Lopez, 1996 and Murray and Acharya, 1997). For the cost associated with illness and disease, public health workers such as the health economist tries to allocate scarce resources in treatment and prevention because the individual household with fixed resource endowment is made to share the limited resources on the consumption of two commodities in health and commodity markets. Havelaar (2007) postulated that the general trend in public health research is the use of integrated metrics to indicate priorities for actions. As Williams (1999) puts it, the principal tasks of organizations responsible for public health care are to monitor the health of the communities they serve and to decide where resources could most efficiently be deployed to improve things.

Disease itself, especially when infectious, does not come without its outcome(s). These outcomes could be in different forms that may limit the individual from productivity, in which case both the individual and the society suffer losses. At times, it may lead to long term or permanent disability, which can be measured by Instrumental Activities of Daily Living (IADL) or Activities of Daily Living (ADL), with the worst case being mortality and at times a premature death causing a BoD. Murray-Lopez (1996), Havelaar (2007) and others have used the Disability Adjusted Life Years (DALYs) as a single composite measure of the different disease outcomes, and it is the summation of the number of years of life lost due to mortality (YLL) and the number of years lived in disability (YLD). It is a health gap measure extending potential years of life lost due to premature death to include equivalent years of 'healthy' life lost in a state of less than full health (Havelaar, 2007). Hence one DALY as defined by the World Health Organization (1996) is one lost year of healthy life. Therefore, we seek to loss DALYs in order to reduce the BoD. The other measure is CoI, which is the summation of direct health care costs, direct non-health care costs, and indirect non-health care costs and excluding indirect health care costs (Oostenbrink et al, 2004).

However, most of the works done in this area so far are those concerning diseases that are not measured by ADL, and those of the temperate regions of the developed countries. Hence, the main objective of this paper is to review these concepts from the points of diseases that are already measured by ADL, especially in the context of tropical diseases of developing countries, where no known cure may be available, with limited resources and limited access to healthcare. It therefore presents

the demand for death being pioneered by Igberaese, Ogheneovo, and Iseghohi (2017), as a remedy to excessive BoD and CoI, when disability is measured beyond IADL and have reached ADL. The paper would be useful as a comprehensive pedagogy document for teachers of health economics and public health, useful to researchers in the health economics and public health workers, policy makers who are interested in health intervention in Nigeria and other countries, especially the developing ones.

It is to be noted that controversies about BoD and CoI have been age long; at least since Murray made a limelight in the area. For example, even in the advanced countries, calculation of BoD is not without its controversy and debates. William (1999) has attacked the Murray-Lopez study of global burden of disease calculation, calling it a waste of high skill resources in what does not really matter. Be that as it may, the issue of BoD calculation has become a doctrine in economics, so that analyzing this principle in settings outside its origin will add to knowledge and give at least a direction on the way to effectively utilize resources in maximizing public health, both on the short run and in the long run.

The rest of the paper brings together and briefly reviews various methods and approaches of calculating the BoD and CoI used by various authors, the necessary steps involved in BoD and CoI calculations, particularly the outcome tree, perspective of evaluation, discounting, data need/surveillance pyramid and co-mortality, as well as review the measures of disability and render some criticisms of the BoD and CoI approaches, with respect to their applications to tropical diseases of the developing countries. It would then suggest alternative systems of intervention since the whole essence of BoI calculation is to identify priority areas for action, save resources and ensure productivity in the economy. This is where Igberaese, et al (2017) pioneering work on demand for death may be introduced.

Review of BoD Calculations and CoI Analysis

Murray and Acharya (1997) write that DALY is one of the composite measures of disease outcomes in the BoD calculation. DALY equation is as follows:

$$DALY = YLL + YLD$$

Where; YLL is number of years of life lost due to mortality and it is calculated as the multiple of the summation of all fatal cases due to healthy outcome of specific disease (d_i) and expected life span of the individual at the age of death (e_i).

$$\text{Thus, } YLL = \sum_i d_i \times e_i$$

YLD is the number of years of life lived in disability, with a weight factor between zero and one for the severity of the disability. It is calculated by the multiple of the summation or accumulation of all cases and all health outcomes (n_i) by the duration of illness (t_i) and the disability weight of a specific disease (w_i).

$$\text{Thus, } YLD = \sum_i n_i \times t_i \times w_i$$

(Murray and Acharya, 1997).

Oostenbrink et al (2004) give the CoI as the accumulated direct health care cost (DHC), direct non-health care cost (DNHC), and indirect non-health care cost (INHC). The calculation excludes indirect health care cost (IHC), which is the future savings on

health care cost as a result of premature death. That is, the cost that would have been incurred in direct medical services if the individual were still alive or if he had not died of the specific illness, but still in a state of less than full health or suffering from disability as a result of the specific disease. It is therefore clear that this cost cannot be determined. DHC are cost of general consultations, cost of specialist consultation, cost incurred as a result of hospital attendance (in-patients or out-patients or both), cost of drugs, cost of rehabilitation and of other disease progressions before the restoration of full health and so on. For each health care outcome of a specific disease and each medical health service, the DHC related to a specific pathogen is given by the equation:

$$\sum_i (\sum_i m_i \times p_i \times mc_i)_I$$

Where: m_i is number of cases requiring health care
 p_i is the required health care service unit per case, and
 mc_i is the cost per health care service unit.

DNHC is the cost incurred on travelling, additional cost incurred on diapers, medical expenditure on other illness different from the specific disease, but discovered during the treatment of the specific disease or co-payment for drugs and other informal cases, like motivation for a caregiver as a result of disability resulting from the specific disease. For each direct non-health care outcome of a specific disease and each non-health care service, the DNHC related to a specific pathogen is given by the equation:

$$\sum_j (\sum_j r_j \times q_j \times rc_j)_I$$

Where:
 r_j is the number of cases requiring non-health care service
 q_j is the required non-health care service unit per case and;
 rc_j is the cost per non-health care service unit.

DNHC is however very negligible and relatively small when compared to the other costs, which are usually included in the CoI analysis. For this reason and for lack of appropriate data, DNHC is also usually not included.

The other cost to be included is INHC, which is the value of production loss to society as a result of absence from work, where temporarily or for permanent or long term disability or premature death. It also includes the loss of productivity from sickness leave of individual and that of a third party taking care of the sick individual. INHC can be calculated as follows for each indirect non-health care outcome of a specific disease and for each type of sickness leave:

$$\sum (\sum_{sk} S_k \times U_k \times V_k)_I$$

Where: S_k is the number sickness leave
 U_k is the duration of sickness leave and;
 V_k is the wage cost per day.
 (Oostenbrink et al, 2004).

Gain from Demand from Death Using BoI Calculation and CoI analysis

From Murray and Acharya (1997)'s BoD calculation, $DALY = YLL + YLD$

When death is demanded at ADL disability, DALY will be equal to YLL, as YLD approaches zero. DALY will simply be the number of years of life lost due to mortality, calculated as the multiple of the summation of all fatal cases due to healthy outcome of specific disease (d_i) and expected life span of the individual at the age of death (e_i).

$$\text{Thus, } DALY = \sum_i d_i \times e_i$$

This is a big reduction in BoD because the only loss becomes the productivity the individual would have engaged in if he had not died of the disease before the age he was normally expected to live. It has removed all the burden that he and the relatives, including that of his caregiver, would have suffered if he had not died, but continued to live in the state of ADL disability, which would have still eventually caused him to die before his expected life span anyway.

From Oostenbrink et al (2004)'s CoI analysis, demand for death will enlarge IHC, which is the future savings on health care cost as a result of premature death. DHC approaches zero, DNHC also approaches zero while INHC remains constant (not increasing) after the time of demand. The calculation would then include indirect health care cost (IHC) because his relatives will be able to determine what they have saved since the death, from what they used to spend during the disability. Then, for each health care outcome of a specific disease and each medical health service, $\sum_i (m_i \times p_i \times mc_i)_i$ approaches zero. For each direct non-health care outcome of a specific disease and each non-health care service, $\sum_j (r_j \times q_j \times rc_j)_j$ approaches zero.

The loss of productivity from sickness leave of individual and that of a third party taking care of the sick individual, calculated as $\sum (s_k \times U_k \times V_k)_k$ remains constant. And IHC, which is the savings from future cost of death approaches infinity.

This again is a great gain from demand from death, as the individual's relatives and the society can channel such resources and energy to other uses that would benefit the household and the economy.

Brief Review of Other Approaches to BoD and CoI

Oostenbrink et al (2004) and Murray-Lopez (1996) give the various approaches to BoD and CoI. The approaches given by the authors can be summarized as follows:

- a. Incidence and Prevalence approach: In the incidence approach, all outcomes, whether now or in the future, are assigned to initial events. Thus, it reflects future BoD and CoI based on current events. On the other hand, prevalence approach accesses BoD and CoI at a point in time and thus reflects current events BoD and CoI based on previous events. The incidence approach is more advantageous for four reasons:
 - i) Communicable diseases have rapid cause and have need to be monitored in the present than in the past because the past is less informative;
 - ii) it is more sensitive to epidemiological trend in the society;

- iii) it gives more information on health gained and the quality of life, and also on related savings due to avoided cost of illness; and,
- iv) evaluation of time lived in disability is more consistent with calculation of time lost to mortality.

However, at steady-state, both approaches are equal and there is also no difference for outcome less than one year.

- b. The outcome and agent-based approach: Murray-Lopez (1996) used the outcome approach in the global BoD calculation. The approach is insensitive to the disease causes but uses the clinically defined category of disease (ICD - codes). The agent-based focuses all relevant outcomes and associated costs that can be attributed to a particular agent, which can cover different disease category (ICD - Codes). This approach gives more insight and allows more comparison than the outcome approach. The agent-based was used by Havelaar et-al (2004) in the calculation for the burden of food borne zoonoses in European countries.

Useful Steps in BoD Calculation and CoI Analysis

The first useful step in the calculation is the outcome tree. Others are perspective of evaluation, discounting, data/surveillance pyramid, co-mortality, and incidence/duration of non-fatal health outcome, number of fatal case and life expectancy of fatal cases. The first most important three are briefly explained below:

The outcome tree is a qualitative representation of the progression of the disease over time. This is done by ordering relevant health state following infection and illustrating their conditional dependency. The first block of infectious disease represents incidence of infection and acute illness, while the subsequent blocks represent the incidence of possible outcome, including recovery and request for specific resources. Its construction means making choices on which outcome or resource request to include and this requires preliminary estimation of all possible impacts of all disease outcomes on total BoD and all possible resource request on total CoI.

The perspective of the evaluation is critical as it defines the perspective taken. It determines which potential costs and subsequent benefits are included. Most studies use third party perspective. Other possible perspectives are the patient perspectives and society perspectives used by Havelaar (2004).

Discounting involves estimation of the Net Present Value (NPV) of each single programme so as to compare the values of different projects. The discount rate applied is often the real rate on returns or long-term government bond (Drummond and O'Brien et al, 1997). With discounting in BoD calculation, future life years are assigned less value than those lived today. Discounting is a subject of controversy in BoD calculation; it results in lower efficiency of prevention programme, especially when the

discount factor is high, and not discounting favours prevention due to benefits in the far future.

Criticisms of Calculation of BoD and CoI in the Case of Tropical Diseases.

Williams (1996) was the first to make a critique on Murray and Co-workers' pioneering study on BoD calculation, calling it a diversion of great deal of high skilled resources and materials for calculations that are not needed for the problem they purport to address, just as the focus is mistaken. These calculations may even be needed for diseases of the temperate region, diseases such as in the case of food borne zoonoses, which are random, low prevalence, low incidence and mostly with few reported cases that can easily be quarantined. The calculations may be necessary in order to prevent waste of resources where the burden is, after all, not much, so as not to pursue shadows. The same cannot be said of diseases of the tropical diseases, which are of highly prevalence, and difficult to quarantined.

For example, one wonders how effective these calculations will be - given the methods and the steps. Diseases like stroke, HIV/AIDS, malaria, heart diseases which have high prevalence rate and rank among the highest killer diseases due to stress and other risk factor in Nigeria. The cost of assembling of materials and gathering data becomes even more tasking and consuming than Williams had envisaged in his criticism of the Global Burden of Disease (GBD) calculation.

The question of sensitivity is: Why and how far do we really need to calculate BoD before action or intervention on diseases with such known severity, diagnosed as killing millions of people simultaneously? Why not just use such resources for example, to fight mosquito, buy mosquito treated net for the venerable poor and acquire the necessary malaria drug - intervention? If such huge resources would first have to be devoted to the calculation of the effects that are already clear, will it not be better to save the energy that would be used in scrubbing a known dirty floor than use it in washing the rag for the job? Put differently, should the many poor in Nigeria, Sudan, Mali, Uganda, Kenya, Central Africa Republic, DR Congo, Ethiopia and other sub-Saharan African countries who are simultaneously attacked in high volume by malaria die while waiting for these calculations before intervention? It makes more economic sense to save resources by direct intervention to increase human capital, productivity by increasing healthy life expectancies than wasting resources calculating the known.

Moreover, there are cases where intervention can only be to stop the spread of such high killer diseases, or reduce the BoD and CoI. That is, in the case where care is no more possible and disability is already severe to the extent that is already measured by ADL recognized by Desai, Robine, Romieu and Michel (2003). Robine, Romieu and Michel (2003) also write that disability is measured by a set of items, which are self-reported limitations with severity of disability ranked by the number of positively answered items. Disabilities in activities of daily living (ADL), which shows dependence of an individual on other individuals to assist in daily life is the most severe case. These activities include among others, feeding, bathing or showering, dressing, transferring from bed and chair. Disability in instrumental ADL is less severe.

This refers to disabilities affecting a broad range of activities, such as telephone use, shopping, housekeeping, preparation of food, doing laundry, use of various types of transport, handling of drugs, and management of finances (Robine, Romieu and Michel, 2003). Again the usual lack of data availability would greatly limit calculation of the disability prevalence in developing countries. Igberaese et al (2017) write that giving the lack of improved medical access, increasing road accidents, stress, unfavourable working conditions such as those of factory workers who can only be compared to robots, low wage, maternal morbidity, increasing prevalence rate of tropical diseases such as malaria, leishmaniasis, schistosomiasis, onchocerciasis, lymphatic filariasis or elephantiasis, chagas disease, Africa typanosomiasis, dengue, meningitis and other diseases such as HIV-AIDS, hemolytic fevers like Lassa, cancer, prostrate and malarial, deteriorating life style due to poverty and so on, one will be correct to say that disability is increasing in Nigeria. In short, the less welfare improves, the more the disability (Igberaese et al, 2017).

Demand for Death

Owing to the above disability condition measured by ADL, a small group of Ph.D students of economics in University of Benin, Igberaese et al (2017) extended the Gruenberg (1997) Failure of Success (FoS) hypothesis to propose the demand for death, which they lament that it is yet to be recognized as a concept in economics, but does exist. Works are still ongoing in this area, and as such, not much literature is available yet for review. FoS hypothesis states that a cohort with a rising proportion of individuals surviving to some late age will have increased disease and disability at that age. The alternative hypothesis is that exceptionally old people generally enjoy the Success of Success (SoS) —that is, increases in the proportion of the population surviving to the highest ages are accompanied by concurrent postponements of physical and cognitive disability (Christensen, Doblhammer, Rau, James and Vaupel, 2010)). Gruenberg (1997) had written that advancement in technology for saving lives and providing more efficient medical care resulted in the paradoxical increase in the prevalence of chronic diseases. Authors such as Christensen, McGue, Petersen, Jeune and Vaupel (2008), Manton (2008), Wang, Zeng, Jeune and Vaupel (1997) and Baltes and Smith (2003) have found that failure of success exits among cohorts in many parts of Europe, even though success of success also applied. Using primary data from Edo communities, the small group endeavoured to evaluate the FoS hypothesis in Nigeria. The case of Nigeria has been found to be entirely a validation of the failure of success hypothesis, just as it is also found that many have demanded to die to end their BoD and CoI, but that it needs to be properly recognized and integrated into the main stream economics.

FoS affects “Healthy” Life Expectancy (HALE) whereby prolonged life is not accompanied by similar extension of healthy life. That is, that longevity does not imply a healthy life (Rogers, Rogers and Balanger, 1990; Verbrugge, 1984 and Olshansky, Rudberg, Carnes, Cassel, and Brody, 1991). HALE also known as Health (Cox and Le Roy, 2006). Expectancy reflects the current health of a real population adjusted for

mortality level and independent of age structure. “Healthy Expectancy” by Sullivan’s method is number of remaining years, at a particular age an individual can expect to live in a health state (e_x). From the total **LE** at age x denoted as e_x in the life table, and the proportion with disability is π_x , the person years lived without disability is $(1 - \pi_x) L_x$, with L_x as person years lived in age x . The summation of person lived years without disability ($\sum (1 - \pi_x) L_x$) is the total year lived without disability. This is then subtracted from **LE** to get **DFLE** or **HALE**. The proportion of remaining life spent disability free can then be calculated by dividing disability free life expectancy by life expectancy ($DFLE_x / e_x$). This life table is a period life table that presents what would happen to a simulated cohort through time if it experienced specified death rates. These death rates are written as $q(x)$, and equal the probability of dying between ages x and $x+1$ (Tucek, 2009).

“Demand for death may be useful as a way of reducing and eliminating the BoD and monetary CoI of the individual, family and the society, as well as increasing productivities by avoiding waste”. Cox and Le Roy (2006) also write that evidence of such demand are scattered in the form of suicide, and that the bad the news of death, the agony of losing a dear one, the societal stigma of suicide, the religious belief in the sin of suicide and the fear of destination of eternal life after death, all contribute to make suicide an abominable act, not to be allowed or contemplated even when the BoD and CoI have become too high for the individual to bear as disability is measured by ADL.

In some cases, the sick individual would wish he had died; the relatives who bear the burden and cost would also wish the individual had died, and most importantly, the physician would know that the disease is chronic and terminal, yet the factors listed above are always considered, making many to be skeptics. As a result of these considerations, death becomes the most expensive commodity ever; at the time it is most desirable and needed to satisfy the human wants of lowering disease burden and minimizing cost of illness, even though its monetary cost may be very low- at times, less than a dollar to buy poison.

The authors believe that the utility from demand for death is when all the parties bearing these unwanted burdens and costs channel energies and resources to alternative uses that would either benefit them or the society since utility itself has its intrinsic value (Zúñiga, 2005).

They however said that demand for death may only be contemplated under the extreme case of self-reported limitations and ADL, and not under instrumental ADL and not by relatives reported limitations. It can only be that the individual with the specific disease desire to die and directly or indirectly ask for it, and not when death occurs from ignorance or risky actions.

Direct and Indirect Demand for Death

Igberaese et al (2017) categorize demand for death into direct and indirect: (i) direct demand for death is when the individual with specific disease eats or injects poisonous substance into his system, either by himself or through the assistant of another person, say a physician or non-physician or clinician and (ii) indirect demand for death is when the individual with the specific illness deliberately ignores the advice of a medical practitioner against certain foods or drinks that are capable of accelerating the death of that individual. Indirect demand for death can occur when the individual refuses to take or be administered drugs that could shift his death time forward into the future or he opts for voluntary discharge from the hospital against the advice of a medical practitioner, in the case of in-patient.

The Economic Importance of Demand for Death

The severely disabled persons consume more, because these persons need both the normal market goods and medical goods. This puts pressure on the already low wage, which is already the case in developing countries. The society too loses from both the severely disabled's inability to work and that of his caregiver. Even though all respondents in Igberaese et al works agreed that the above situations hold, only the expert medical professionals succumb to the demand for death to lessen BoD and CoI, as well as the use of medical assistants to minimize the cost of dying. Self-medicated poison may lead to unwarranted kind of death process, lengthen the process of dying, and might injure some of the unaffected internal organs (which could be voluntarily donated to others) and make the individual unhealthy even at death. Therefore, demand for death may help optimize dying process; to make such death less painful, less stressful and very peaceful when disability is already measured by ADL.

Demand for death can also free resources for investment in development process. This is very easy to imagine: given the high prevalence of ADL disability in many developing countries due to the tropical diseases earlier reported here, and the fact that these individuals affected consume both medical goods and normal market goods, it can be estimated that the income spent on medical goods amounts to billions of dollars annually, which is a loss to both the individuals' family and the nation. For example, a president of Nigeria in 2009 flew abroad for treatment for severe internal organ failure; a pure case of ADL disability. A lot of resources were invested in him in the mist of core poverty among the people, yet he died, and with no accountability.

Summary and Conclusion

The works of Murray and co-workers on calculating BoD have sparked off controversies in health economics, even as it is with CoI. The purpose is to fully understand the priority areas for public health intervention in order to effectively allocate scarce resources. But if resource allocation is the ultimate in the calculation, authors opine that it would amount to waste of same resources. This paper attempted to bring together the methodologies for such calculation of BoD; DALY, which is YLL + YLD, as well as analyze the CoI; DHC, DNHC, INHC, IHC. Added to the criticisms

found in literature, the paper posits reasons why BoD calculation and CoI analysis may prove to be even more difficult in developing countries. Firstly, data are not available. Secondly, unlike the diseases of the temperate regions, which are less prevalent and thus easy to quarantine, diseases of the tropic regions are usually of high prevalence, making quarantine impossible and making the exercise very expensive, even for burden and cost that are already clear. Instead of these calculations, the paper introduces the demand for death for ADL disability, being pioneered by Igberaese and co-workers as a way of eliminating the BoD and CoI. Demand for death can be categorized into two: These are direct and indirect demand for death. In the case of direct demand, the patient eats or injects poisonous substance into his system, either by himself or through the assistance of a medical practitioner. This includes foods he is medically advised against in order to postpone his death time. Indirect demand for death is when ADL disabled person refuses to be administered drugs that could shift his death time into the future or opt for discharge from the hospital, in the case of an in-patient. It stresses that such demand for death can only be in the case where disability is already measured beyond Instrumental ADL and is at the level of ADL measurement, and that the patient concerned must express that he wants to die, not when relatives want him to die. Besides making the process of dying for such patients easy and saving some of the organs unaffected by the disease or illness, it would free a lot of resources for development process.

In conclusion, the works involved in BoD calculation and CoI analysis, are too complicated and unrealistic for topical diseases. It would amount to a waste of time and high level resources in areas where resources are already scarce. Intervention in these high prevalent diseases should be more urgent than calculation and analysis, especially for communicable diseases. However, when such disease has led to ADL disability, demand for death should be considered.

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