Disability-Adjusted Life Year conversion

CASE STUDY #5: POSTPARTUM HEMORRHAGE CASES TO DALYS

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AIM

The objective of this study is to convert disease-specific health outcomes (i.e., *postpartum hemorrhage* [PPH] cases) reported in economic evaluations to disability-adjusted life years (DALYs), a standardized health outcome measure that captures both longevity and morbidity. We estimated DALYs attributable to PPH cases from 89,254 deliveries in 33 Nigerien facilities according to the results of an analysis conducted by Broughton and colleagues [1]. Since this paper reported both PPH cases and DALYs, it was a suitable candidate for a case study to illustrate the conversion process and calibrate the DALY estimation from our online calculator.

METHODS

PARAMETERS

We extracted relevant information from Broughton et al.'s 2013 paper "Cost-effectiveness of a quality improvement collaborative for obstetric and newborn care in Niger". [1] The target population consisted of women from 33 Nigerien facilities that participated in a quality improvement collaborative intervention between 2006 and 2008. Outcomes of the study were reported in DALYs as well as the number of PPH cases before and after the implementation of the collaborative. We aimed to use the number of PPH cases to recreate DALYs and compare the estimated DALYs from our calculator to the reported estimate. The numbers of incident cases and deaths were calculated based on the information provided from the study. No parameter was sourced externally. A full list of parameters can be found in Table 1.

ONLINE CALCULATOR

The online DALY calculator is a Web app that, on individual and population levels estimates years of life lost (YLL), years lived with disease (YLD), and total DALYs attributable to a particular disease. Further details regarding the DALY calculator are published elsewhere. [2] To add precision to the original calculator, we updated the original standard life expectancy table with country- and gender-specific life expectancy. As users are not able to specify custom disability weights and life expectancy inputs, the expectation was that the calculator would provide an approximate estimate for this conversion; the goal was to explore and calibrate its accuracy and usability. PPH disease

options with disability parameters closest to those reported in the original article were selected to estimate YLLs for each disease stages.

CUSTOM R CODE

The function underlying the online DALY calculator can be imported into the statistical package R [3] and used with custom parameter inputs. To improve usability of the online calculator, disability weights and life expectancy at death are fixed parameters pulled from standardized data sources [4-6] depending on disease, country, gender and age of death input by a user. These standardized values, however, do not exactly match the parameters used by Broughton et al. The disability weights for each disease state used in our calculator [4] are different from those in the source paper. The disability weight was 0.093 for severe anemia from PPH and 0.046 for moderate anemia as reported by Broughton et al. We applied the standard disability weight of 0.149 for severe anemia from PPH and 0.052 for moderate anemia from PPH. This may overestimate DALYs compared to those reported by Broughton et al. In addition, the paper reported a life expectancy at age 26 of 54 years, while the online calculator assumes it to be 46 years based on global estimates. This may underestimate DALYs compared to those reported by Broughton et al. However, both the overestimation and underestimation are consistent for both the pre- and post-collaborative, thus the direction of bias for the incremental health outcomes due to treatment (quality improvement collaborative) is uncertain. To obtain a more accurate estimation, we used the underlying code from the online calculator tool to customize disability values and life expectancy to match exactly those reported in the paper by Broughton et al. This code can be found in Appendix 1.

ESTIMATE CALCULATION

Broughton et al. categorized their study cohort according to two disease stages, to which different disability weights are attached. We estimated DALYs averted for each disease stage and summed the two averted DALY estimates to arrive at the total DALYs averted for the quality improvement collaborative.

RESULTS

Estimated DALYs in this population can be found in Table 2. The original paper reported incremental costs of $217,000 and incremental cost-effectiveness ratio of $286/DALY, based on an estimated 759 DALYs averted. By using GBD life expectancy for Nigerien women, our online calculator estimated 756 DALYs averted. Using our custom R code, we estimated that 783 DALYs averted.

The difference between the number of DALYs estimated by the online calculator and the custom R code stems from the use of standardized disability weights and life expectancy estimates in the online calculator versus custom parameters in the custom R code. Differences between population-based DALY estimates created by our methods and those reported by Broughton et al. are less than 3%. While this translates into larger percentage differences in terms of DALYs averted, the absolute differences are small and unlikely to

change conclusions regarding cost-effectiveness. The remaining differences are likely because of the rounding mechanisms throughout the calculation process used in the paper.

In summary, the use of both the DALY calculator and customized R code produced estimates of DALYs that were comparable to those used in an original, published cost-effectiveness evaluation of a targeted algorithm for PPH case finding among women in Niger.

Table 1: Parameters

	Description	Number		Source reported in article	Source externally
Disability weight	Moderate anemia from PPH	0.093		Broughton et al (2013) [1]	
	Severe anemia from PPH	0.046			
Life expectancy	Niger population	54		Broughton et al (2013) [1]	
Age of onset		26		Broughton et al (2013) [1]	
Age of death	Age of onset plus length of moderate anemia from PPH to death	26.5		Broughton et al (2013) [1]	
	Age of onset plus length of moderate anemia from PPH to death	26.25			
Incident cases		**Pre**	**Post**	Broughton et al (2013) [1]	
	Moderate anemia from PPH	730	86		
	Severe anemia from PPH	129	15		
Incident deaths	Moderate anemia from PPH	0	0	Broughton et al (2013) [1]	
	Severe anemia from PPH	30	5		
Discount rate	3%				
Age weighting	4%				

Table 2: Outcomes of DALY conversion calculation on online calculator and with custom R code

	Pre-quality improvement		Post-quality improvement		Differences
	Description	**DALYs**	**Description**	**DALYs**	**DALYs averted**
Broughton et al.					759
	Moderate anemia from PPH	0	Moderate anemia from PPH	0	
Online Calculator	Severe anemia from PPH	907	Severe anemia from PPH	151	
	Total	**907**	**Total**	**151**	**756**
	Moderate anemia from PPH	12	Moderate anemia from PPH	1	
Custom R code	Severe anemia from PPH	927	Severe anemia from PPH	154	
	Total	**939**	**Total**	**155**	**784**

REFERENCES

1.   Broughton, E., et al., *Cost - effectiveness of a quality improvement collaborative for obstetric and newborn care in Niger.* International journal of health care quality assurance, 2013.

2.   David Kim, J.E., *Disability Adjusted Life Years (DALY) Calculator: Methodology.* 2018, Center for the Evaluation of Value and Risk in Health, Tufts Medical Center.

3.   Team, R.C., *R: A language and environment for statistical computing.* 2013, R Foundation for Statistical Computing: Vienna, Austria.

4.   Salomon, J.A., et al., *Common values in assessing health outcomes from disease and injury: disability weights measurement study for the Global Burden of Disease Study 2010.* The Lancet, 2012. **380**(9859): p. 2129-2143.

5.   Wang, H., et al., *Global, regional, and national under-5 mortality, adult mortality, age-specific mortality, and life expectancy, 1970–2016: a systematic analysis for the Global Burden of Disease Study 2016.* The Lancet, 2017. **390**(10100): p. 1084-1150.

6.   *Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2017 (GBD 2017) All-cause Mortality and Life Expectancy 1950-2017.* Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2018.

Appendix 1: Custom R code used to calculate DALYs

```
library('devtools')
install_github('TuftsCEVR/DALYCalculator')
library('DALYcalculator')

#Broughton 2013: postpartum hemorrhage

#POPULATION LEVEL
#Pre TREATMET
  #DALYs estimates for each disease state among Nigerian women from participating
facilities
  #Moderate anemia from PPH:
    Pre_M_DALY<-DALYcalculator::f_DALYpop(K=1, C = 0.16243, r=0.03, beta=0.04,
a_death=26.25, a_disability=26, YLL_L=54, D=0.046 ,incident_cases = 730,
incident_deaths = 0)[3]
    Pre_M_DALY
  #Severe anemia from PPH:
    Pre_S_DALY<-DALYcalculator::f_DALYpop(K=1, C = 0.16243, r=0.03, beta=0.04,
a_death=26.5, a_disability=26, YLL_L=54, D=0.093 ,incident_cases = 129,
incident_deaths = 30)[3]
    Pre_S_DALY
  #add together to get full DALY estimate
    Pre_DALY <- Pre_M_DALY + Pre_S_DALY
    Pre_DALY

#Post TREATMENT
  #Moderate anemia from PPH:
    Post_M_DALY<-DALYcalculator::f_DALYpop(K=1, C = 0.16243, r=0.03, beta=0.04,
a_death=26.25, a_disability=26, YLL_L=54, D=0.046 ,incident_cases = 86,
incident_deaths = 0)[3]
    Post_M_DALY
  #Severe anemia from PPH:
    Post_S_DALY<-DALYcalculator::f_DALYpop(K=1, C = 0.16243, r=0.03, beta=0.04,
a_death=26.5, a_disability=26, YLL_L=54, D=0.093 ,incident_cases = 15,
incident_deaths = 5)[3]
    Post_S_DALY
  #add together to get full DALY estimate
    Post_DALY <- Post_M_DALY + Post_S_DALY
    Post_DALY
  #To display DALY averted
    Pre_DALY - Post_DALY
```

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