HHS Public Access

Author manuscript

Front Public Health Serv Syst Res. Author manuscript; available in PMC 2015 August 25.

Published in final edited form as:

Front Public Health Serv Syst Res. 2015 July ; 4(4): 21–28. doi:10.13023/FPHSSR.0404.04.

Economic Evaluation of Fungal Meningitis Outbreak Response in New River Valley: Local Health Department Perspective

Kaja M. Abbas,
Virginia Tech, kaja.abbas@gmail.com

Nargesalsadat Dorratoltaj,
Virginia Tech, nargesd@vt.edu

Margaret L. O'Dell,
New River Health District, Virginia Department of Health, Molly.ODell@vdh.virginia.gov

Paige Bordwine,
New River Health District, Virginia Department of Health, Paige.Bordwine@vdh.virginia.gov

Thomas M. Kerkering, and
Virginia Tech Carilion School of Medicine, tmkerkering@carilionclinic.org

Kerry J. Redican
Virginia Tech, kredican@vt.edu

Abstract

Background—The multi-state fungal meningitis outbreak started in September 2012 in Tennessee. The cause of the outbreak was injection of contaminated lots of methylprednisolone acetate used in epidural spinal injections. Roanoke and New River Valley were the epicenter of this outbreak in Virginia, with two clinical centers having administered the contaminated injections to their patients. New River Health District, in coordination with hospitals, and state and federal agencies, deployed its resources to control the local impact of the outbreak.

Purpose—The objective of this study was to conduct an economic evaluation of the fungal meningitis outbreak response in New River Valley of Virginia, from the local public health department perspective.

Methods—The health department conducted the outbreak investigation from October 2012 until March 2013 to ascertain that all possible cases were identified and treated. Data were collected on the costs associated with the local health department in the outbreak response, and the epidemiologic effectiveness estimated, using the metric of disability adjusted life years (DALYs).

Results—The cost incurred by the local health department was estimated to be $30,493; the epidemiologic effectiveness was estimated to be 138 DALYs averted among the patients, for an incremental cost-effectiveness ratio of $221 per DALY averted.

There is no conflict of interest.

Implications—The incremental cost effectiveness ratio of the fungal meningitis outbreak response in New River Valley assists the local health department to analyze the costs and epidemiologic effectiveness of the outbreak response.

Keywords

Cost-effectiveness analysis; fungal meningitis outbreak; local health department; Virginia

INTRODUCTION

In September 2012, the Centers for Disease Control and Prevention (CDC) initiated an outbreak investigation of fungal meningitis, in collaboration with local and state health departments, and Food and Drug Administration (FDA). Tennessee Department of Health culture confirmed cases of *Aspergillus fumigatus* meningitis following epidural steroid injection in September 2012.[1] After Tennessee, 19 more states reported fungal meningitis cases, caused by the predominant pathogen *Exserohilum rostratum*. The cause of the multi-state fungal meningitis outbreak was traced to contaminated lots of preservative free methylprednisolone acetate that were used in the epidural steroid injections. Twenty-three states had received the contaminated lots, and more than 13,000 patients had received the contaminated epidural steroid injections, and were at risk of developing fungal meningitis. There were 751 cases and 64 deaths in 20 states as of October 23, 2013, and additional cases are not anticipated.[2]

Virginia reported the fourth-highest number of cases with 54 cases and 5 deaths. New River Health District is one of 35 local health districts of the Virginia Department of Health in Virginia. It is among 11 health districts in Virginia with residents who were injected with fungal-contaminated epidural steroids. Two clinical facilities in Virginia had administered these fungal contaminated injections, with one facility located in New River Valley and the other facility located in neighboring Roanoke. New River Health District personnel conducted disease surveillance, case reporting, and referring probable cases to clinical facilities for diagnostics, treatment and/or hospitalization. In this study, a cost-effectiveness analysis was conducted of the fungal meningitis outbreak response in New River Valley, from the (New River Health District) local health department perspective.

METHODS

Cost and effectiveness of the fungal meningitis outbreak response by the New River Health District is compared to the do-nothing alternative (scenario of no intervention). Effectiveness measures the combined epidemiologic impact of morbidity and mortality using the metric of disability-adjusted life years (DALYs).[3] DALYs averted are equivalent to quality adjusted life years (QALYs) gained. The time horizon of this study was from October 2012 to March 2013 from the New River Health District perspective, and no discount rate is used.

Costs

Total direct cost incurred by the New River Health District for the fungal meningitis outbreak response is estimated based on the product of the total hours spent by their different personnel (collected from their time logs), and hourly wages of the corresponding personnel (collected from the New River Health District).

Effectiveness

Effectiveness, that is the epidemiologic impact, is measured using the metric of DALYs averted. DALYs measures the burden of (disease) fungal meningitis, as a combined metric of the epidemiologic impacts of morbidity and mortality. Morbidity impact is measured by years of life lost due to disability (YLD), and mortality impact is measured by years of life lost due to premature mortality (YLL). The equations for YLD, YLL and DALY are below:

$$YLD = Number\ of\ incident\ cases * Disability\ weight * Average\ duration\ of\ disease \quad (1)$$

$$YLD = Number\ of\ incident\ cases * Case\ fatality\ rate * (Life\ expectancy - Age\ of\ death) \quad (2)$$

$$DALY = YLD + YLL \quad (3)$$

Cost effectiveness

Cost effectiveness is measured using the metric of incremental cost effectiveness ratio (ICER). ICER is computed as the ratio of the difference in costs and the difference in effectiveness (epidemiologic impact) of the fungal meningitis outbreak response by the New River Health District, compared to the do-nothing alternative. The equations for ICER are below:

$$ICER = \frac{Cost(outbreak\ response) - Cost(do - nothing\ alternative)}{Effectiveness(outbreak\ response) - Effectiveness(do - nothing\ alternative)} \quad (4)$$

RESULTS

Figure 1 illustrates the decision tree to compare the fungal meningitis outbreak investigation of the New River Health District with the do-nothing alternative.

Costs

Table 1 illustrates the distribution of time spent and wages of different personnel of the New River Health District, who were involved in the fungal meningitis outbreak response. The total direct cost is estimated to be $30,492.9.

Effectiveness (DALY = YLD + YLL)

Years of life lost due to disability (YLD)—None of the 91 patients in New River Health District met the case definition of fungal meningitis, as defined by CDC. Using the average attack rate of 7.7% for fungal meningitis in Virginia among the patients who had

received the contaminated epidural steroid injections, 7 potential cases were estimated; that is, 7 potential cases (91 patients * 7.7% attack rate = 7 potential cases) are projected as a proxy estimate. Disability weight specific to fungal meningitis is not available, since it is a novel and rare disease. Disability weight of 0.615 for bacterial meningitis,[4] which has similar symptoms to fungal meningitis, is used as the disability weight for fungal meningitis. The average duration of treatment is 4 months for recovered patients, while the average duration of treatment among the fatal patients is near null. Using equation (1), YLD averted is computed to be −1.28 DALYs averted due to the fungal meningitis outbreak response compared to the do-nothing alternative.

Years of life lost due to premature mortality (YLL)—The case fatality rate of fungal meningitis patients is 9.678% with treatment, while it is 100% without treatment. The average life expectancy in Virginia is 79 years, while the average age of patients in Virginia who were injected with fungal contaminated epidural steroids is 57 years. Using equation (2), YLL averted is computed to be 139.10 DALYs averted due to the fungal meningitis outbreak response compared to the do-nothing alternative.

Disability adjusted life years—Using equation (3), total DALYs is computed to be 137.82 DALYs averted due to the fungal meningitis outbreak response compared to the do-nothing alternative.

Cost effectiveness—Using equation (4), incremental cost-effectiveness ratio (ICER) is computed to be $221.25 per DALY averted due to the fungal meningitis outbreak response compared to the do-nothing alternative.

IMPLICATIONS

The total direct costs incurred by New River Health District were estimated for the fungal meningitis outbreak response to be $30,493; morbidity impact of −1.28 DALYs for years of life lost due to disability averted, mortality impact of 139.10 DALYs for years of life lost due to premature mortality averted, and resulting in a combined morbidity and mortality impact of 137.82 DALYs averted for epidemiologic effectiveness of the fungal meningitis outbreak response compared to the do-nothing alternative. The incremental cost-effectiveness ratio (ICER) of the fungal meningitis outbreak response in New River Valley, Virginia was estimated to be $221.25 per DALY averted due to the fungal meningitis outbreak response compared to the do-nothing alternative, from the local health department perspective (New River Health District).

Public health implications

Economic evaluation of the fungal meningitis outbreak response in New River Valley assists the local health department to analyze the costs and epidemiologic effectiveness of the outbreak response compared to the do-nothing alternative. The disability adjusted life year (DALY) metric provides a uniform metric to estimate and compare the burden of different diseases. Thereby, the incremental cost-effectiveness ratio ($/DALY averted) assists the local health department with an objective and uniform metric to evaluate and compare different disease control and prevention programs.

Limitations

The cost calculations include only the direct and fringe costs (salary + benefits) of the New River Health District personnel; indirect costs are not included. We focused on the clinically meaningful values for the variables used in this cost-effectiveness analysis; uncertainty and sensitivity analysis is not included. While the fungal meningitis outbreak response required a coordinated effort by the CDC, FDA, state and local health departments,[5,6] and includes the clinical response of diagnosis and treatment, the perspective of this analysis has focused only from the local health department perspective. While the epidemiologic effectiveness among the patients in New River Valley is a combined result of the coordinated outbreak response of the health departments (local, state and federal) and the clinical facilities (labs and hospitals), the cost calculations has included only the costs incurred by the local health department (New River Health District). Due to this asymmetry in the boundaries of calculation of effectiveness and costs, this study is a partial economic evaluation of the fungal meningitis outbreak response in New River Valley.

Acknowledgment

Ethics approval for this study has been received from the Institutional Review Boards of Virginia Tech and Virginia Department of Health. Research reported in this publication was supported by the National Coordinating Center for Public Health Services and Systems Research, and the National Institute of General Medical Sciences of the National Institutes of Health under Award Number R01GM109718. The content is solely the responsibility of the authors and does not necessarily represent the official views of the funding agencies. Kaja Abbas received a grant from the National Coordinating Center for Public Health Services and Systems Research, University of Kentucky to conduct this study. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

REFERENCES

1. Kainer MA, Reagan DR, Nguyen DB, et al. Fungal infections associated with contaminated methylprednisolone in Tennessee. N Engl J Med. 2012 Dec 6; 367(23):2194–2203. [PubMed: 23131029]
2. Multistate Outbreak of Fungal Meningitis and Other Infections. [cited 2015 May 31] CDC [Internet]. Available from: http://www.cdc.gov/hai/outbreaks/meningitis.html.
3. Murray CJL, Vos T, Lozano R, et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. The Lancet. 2012 Dec 15; 380(9859):2197–2223.
4. WHO. WHO; Metrics: Disability-Adjusted Life Year (DALY) [Internet]. Available from: http://www.who.int/healthinfo/global_burden_disease/metrics_daly/en/ [cited 2015 May 31]
5. Bell BP, Khabbaz RF. Responding to the outbreak of invasive fungal infections: the value of public health to Americans. JAMA. 2013 Mar 6; 309(9):883–884. [PubMed: 23364868]
6. Corvese K, Forlano L, Gibson L. A hybrid strategy for surveillance of individuals potentially exposed to contaminated methylprednisolone acetate—Virginia, 2012. J Public Health Manag Pract. 2013 Aug; 19(4):289–293. [PubMed: 23719390]

SUMMARY BOX

What is already known about this topic?

Local health departments conducted disease surveillance, case reporting, and referring probable cases to clinical facilities for diagnostics, treatment, and/or hospitalization during the 2012–2013 multi-state fungal meningitis outbreak in the United States.

What is added by this report?

This report illustrates the cost-effectiveness analysis of the fungal meningitis outbreak response in New River Valley, Virginia, and estimates the incremental cost-effectiveness ratio to be $221 per DALY averted from the local health department perspective.

What are the implications for public health practice, policy, and research?

Economic evaluation of the fungal meningitis outbreak response in the New River Valley quantifies the costs and epidemiologic effectiveness from the local health department perspective. Incremental cost-effectiveness ratio ($/DALY averted) assists the local health department with an objective and uniform metric to evaluate and compare different disease control and prevention programs.

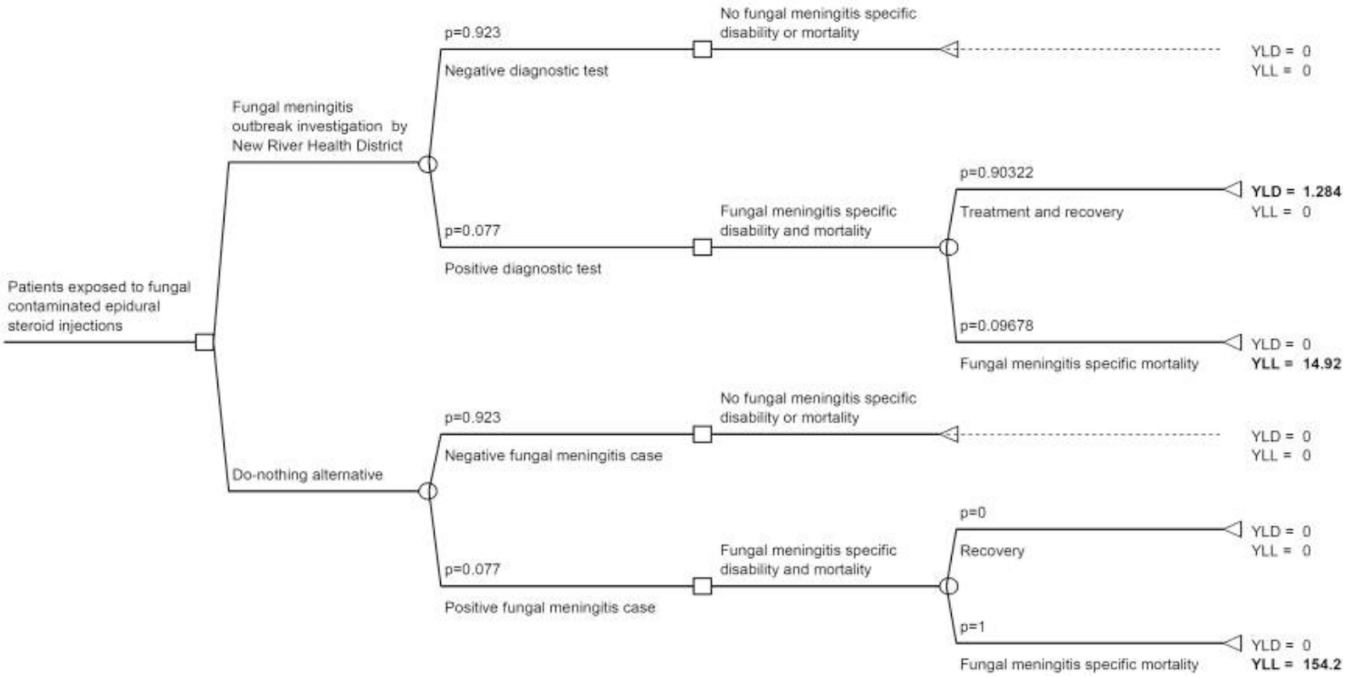

Figure 1.

The decision tree compares the fungal meningitis outbreak investigation of the New River Health District with the do-nothing alternative.

Table 1

Costs incurred by the New River Health District to control the fungal meningitis outbreak in New River Valley

New River Health District Personnel	Total hours	Hourly wage (salary + benefits)	Cost
Epidemiologists	386	$43.3	$16,748.5
Health District Director	70.5	$95.7	$6,746.9
Planner	32	$48.7	$1,558.7
Environmental Health Manager	12	$42.6	$511.0
Clerical	12	$31.0	$372.8
Administration	8	$30.0	$240.0
Nurse Epidemiologist	16	$36.0	$575.5
Volunteers	143	$26.2	$3,739.5
Total cost			**$30,492.9**

Table 2

Effectiveness of the fungal meningitis outbreak and response in New River Valley is measured by Disability-Adjusted Life Years (DALYs) averted

PARAMETER	ESTIMATION
Number of potential cases (proxy for incident cases)	7
Disability weight	0.615 [95% CI: 0.613, 0.616]
Average duration of treatment of recovered patients (proxy for average duration of disease)	0.33 years [mean: 4 months; range: 1.5–18 months]
Average duration of treatment of fatal patients	~ 0 years [range: 1–8 days; 1 outlier case: 44 days]
YLD (outbreak response)	1.28 DALYs
YLD (do-nothing alternative)	0 DALYs
YLD (averted)	YLD (do-nothing alternative) − YLD (outbreak response) = 0 – 1.28 = –**1.28** DALYs averted
Case fatality rate	
- outbreak response	9.678%
- do-nothing alternative	100%
Average life expectancy in Virginia	79 years
Average age of patients (proxy for average age of death)	57 years
YLL (outbreak response)	14.90 DALYs
YLL (do-nothing alternative)	154.00 DALYs
YLL (averted)	YLL (do-nothing alternative) − YLL (outbreak response) = 154.00 − 14.90 = **139.10** DALYs averted
DALYs (averted)	YLD (averted) + YLL (averted) = −1.28 + 139.10 = **137.82** DALYs averted

YLD – Years Lost due to Disability

YLD = Number of incident cases * Disability weight * Average duration of disease

YLL – Years of Life Lost due to premature death

YLL = Number of incident cases * Case fatality rate * (Life expectancy − Age of death)

DALY – Disability Adjusted Life Year; One DALY equals one lost year of healthy life.

DALY = YLD + YLL