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Evaluation of fixed and variable hospital costs due to *Clostridium difficile* infection: institutional incentives and directions for future research☆

P. Ryan [a], M. Skally [b], F. Duffy [c], M. Farrelly [d], L. Gaughan [e], P. Flood [f], E. McFadden [b], F. Fitzpatrick [b,g,*]

[a] *Centre for Health Policy and Management, Trinity College Dublin, Dublin, Ireland*
[b] *Department of Clinical Microbiology, Beaumont Hospital, Dublin, Ireland*
[c] *Department of Infection Prevention and Control, Beaumont Hospital, Dublin, Ireland*
[d] *Department of Finance, Beaumont Hospital, Dublin, Ireland*
[e] *Department of Pharmacy, Beaumont Hospital, Dublin, Ireland*
[f] *General Services Department, Beaumont Hospital, Dublin, Ireland*
[g] *Department of Clinical Microbiology, The Royal College of Surgeons in Ireland, Dublin, Ireland*

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SUMMARY

Background: Economic analysis of *Clostridium difficile* infection (CDI) should consider the incentives facing institutional decision-makers. To avoid overstating the financial benefits of infection prevention, fixed and variable costs should be distinguished.
Aim: To quantify CDI fixed and variable costs in a tertiary referral hospital during August 2015.
Methods: A micro-costing analysis estimated CDI costs per patient, including the additional costs of a CDI outbreak. Resource use was quantified after review of patient charts, pharmacy data, administrative resource input, and records of salary and cleaning/decontamination expenditure.
Findings: The incremental cost of CDI was €75,680 (mean: €5,820 per patient) with key cost drivers being cleaning, pharmaceuticals, and length of stay (LOS). Additional LOS ranged from 1.75 to 22.55 days. For seven patients involved in a CDI outbreak, excluding the value of the 58 lost bed-days (€34,585); costs were 30% higher (€7,589 per patient). Therefore, total spending on CDI was €88,062 (mean: €6,773 across all patients). Potential savings from variable costs were €1,026 (17%) or €1,768 (26%) if outbreak costs were included. Investment in an antimicrobial pharmacist would require 47 CDI cases to be prevented annually. Prevention of 5%, 10% and 20% CDI would reduce attributable costs by €4,403, €8,806 and €17,612. Increasing the incremental LOS attributable to CDI to seven days per patient would have increased costs to €7,478 or €8,431 (if outbreak costs were included).

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* Corresponding author. Address: Department of Clinical Microbiology, Royal College of Surgeons in Ireland, Smurfit Building, Beaumont Hospital, Dublin 9, Ireland. Tel.: +35 3868164447.
E-mail address: fidelmafitzpatrick@rcsi.ie (F. Fitzpatrick).

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Conclusion: As much CDI costs are fixed, potential savings from infection prevention are limited. Future analysis must consider more effectively this distinction and its impact on institutional decision-making.

Introduction

Clostridium difficile infection (CDI) is associated with significant morbidity and economic costs.[1] In Ireland, the national inpatient CDI rate is 3.4 per 10,000 bed-days used.[2] In addition to prolonged hospital stay, additional investigations, treatments and potential mortality, hospital-acquired infections (HAIs) such as CDI impose an economic cost to the healthcare system and society.[3] Costing CDI is essential to inform business case development for investment in infection prevention and control (IPC) services. As institutions face competing demands on scarce resources, IPC practitioners must be able to offer a compelling case for investment. This not only requires IPC expertise, but an understanding of economic analysis and the incentives facing institutional decision-makers. The ability to frame cost arguments appropriately may be decisive in securing IPC funding.

Irish public hospitals receive annual block funding with other sectors (e.g. long-term care) separately funded. Hospitals also receive insurance payments for privately insured patients, although this is limited by regulation.[4] Variable costs (e.g. prescription medicines) vary with the level of output, whereas fixed costs (e.g. equipment) do not. In this funding model, CDI prevention would achieve some 'cash savings' if variable costs could be reduced. However, other perceived cost savings would be notional as resources would instead be directed elsewhere (e.g. staff would spend time treating other patients rather than patients with CDI).

A wide range of CDI costs have been reported, ranging from €5,798 to €11,202 per case in European hospitals, from £4,000 to £10,956 in the UK, and from $2,992 to $29,000 in the USA.[5–7] If the median cost of hospital-acquired CDI were generalized to the USA, the annual national economic burden would be $496 million.[1] The applicability of these studies to the Irish context is questionable. Only eight of 89 publications (9%) on HCAI costs exhibited a high degree of transferability across regions.[8]

We assessed the economic impact of CDI during August 2015 in our institution, with a secondary analysis of potential capacity to lower aggregate spending by CDI prevention, and the value for money this could offer.

Methods

Beaumont Hospital is a tertiary referral public hospital with 820 beds. As only 15% of beds are single en-suite rooms, most patients are accommodated in six-bed bays with one shared bathroom. Daily onsite *C. difficile* laboratory testing involves a two-step protocol (testing for *C. difficile* toxin B gene *tcdB* by polymerase chain reaction (PCR), and, if positive, testing for *C. difficile* toxin). All positive inpatient specimens are sent to laboratories abroad for ribotyping. Positive results are phoned daily by the clinical microbiologist to discuss relevance and recommended management plans. After discussion and clinical review, if CDI is deemed to be the most likely cause of the patient's symptoms, the patient is managed as CDI. CDI patients are isolated in a single room with contact precautions and managed with anti-CDI medications, and, on discharge, hydrogen peroxide decontamination is performed of the single room prior to new patient admission.[9]

The study period was the month of August 2015. The study was registered as a clinical audit and approved by the hospital Clinical Governance Committee. A CDI outbreak occurred in late July and August 2015, resulting in bed closures on the affected ward. A number of measures were taken to address deficits identified during the outbreak, during the study period.

Two detailed micro-costing analyses were conducted: (i) all hospital inpatients with positive *C. difficile* laboratory results in August 2015 were included in an analysis of 'routine' CDI costs; (ii) additional costs attributable to the CDI outbreak during August 2015 were also calculated.

A retrospective chart review of all CDI patients was conducted.[10,11] Patient demographics, length of stay (LOS), diagnosis and diagnosis-related group (DRG) codes on discharge [or International Classification of Disease (ICD) diagnostic codes when DRGs were unavailable], time in isolation due to CDI and additional medications, consultations, investigations, and procedures because of CDI were collected. Unit costs of laboratory testing, personal protective equipment, single room accommodation, cleaning/decontamination and personnel time were sourced from Beaumont Hospital.

At Beaumont Hospital it is protocol to take patients out of isolation after 48 h have elapsed since the patients' symptoms of CDI resolved. We assumed that patients spent no more than 10 days in isolation as a direct result of CDI, therefore any additional days in isolation were disregarded (some patients may have been in single rooms for prolonged periods for other reasons). LOS for each CDI patient was compared to the LOS for a cohort of patients with the same DRG/ICD codes to calculate the incremental LOS attributable to CDI. The comparator group comprised inpatients of similar age (± 10 years) during the two months before and after the study period.

The unit cost of each additional day spent in hospital was derived from national estimates of cost per DRG. The intensity of care may taper over time; therefore for all patients deemed to have a prolonged LOS due to CDI, the DRG with the lowest daily cost was chosen and applied to all patients.[12,13] This created a more conservative estimate to reflect the potential tapering in costs of care over time. A further analysis involved a comparison of actual LOS against national estimates of average LOS which are based on hospital utilization and cost data.[12]

For the CDI outbreak, the following additional data were collected; personnel time including outbreak meetings and administration; additional outbreak-related cleaning/decontamination, and bed closures directly attributable to the outbreak. This enabled estimation of the number of deferred elective admissions. These were attached to unit costs to estimate the value of bed-days forgone.