Hospital and societal costs of antimicrobial-resistant infections in a Chicago teaching hospital: implications for antibiotic stewardship

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Ten years ago, Prof. Levy co-authored a notable paper applying economics to analyse antimicrobial resistance (AMR)[1]. It describes economic analysis of the Chicago Antimicrobial Resistant Project dataset, with the aim of measuring the cost attributable to antimicrobial resistant infections (ARI) in hospitalised patients.

A random sample of high-risk patients hospitalised in 2000 in Chicago was selected. To increase the number of patients for the subgroup analysis, additional high risk patients with antibiotic resistant organisms were selected. A sensitivity analysis including three study designs was conducted. Regression was used to adjust for potential confounding in the random sample and in the sample expanded with additional patients with ARI. Propensity scores were used to select matched control subjects for each patient with ARI for a comparison of mean cost for patients with and without ARI. All patient resource use was abstracted from electronic and paper medical records. Service costs included all support costs related to administration, employees, buildings, etc.

In 2009, drug-resistant organisms were classified in four subgroups: (1) methicillin-resistant *Staphylococcus aureus*, (2) vancomycin-resistant enterococci, (3) *Escherichia coli* resistant to fluoroquinolones / 3rd generation cephalosporins or *Klebsiella* species resistant to 3rd generation cephalosporins and (4) amikacin- or imipenem-resistant *Enterobacter*, *Pseudomonas* or *Acinetobacter* species.

23,904 patients were hospitalised and 4,944 (20.7%) met the eligibility criteria. The random sample of 1,253 patients was expanded by 138 patients with ARI, resulting in a total of 1,391 patients, of whom 188 (13.5%) had ARI. Patients with ARI had significantly different APACHE III scores, HAI rates and death rates compared to those without ARI. Among those with ARI, 34 (18.1%) died compared with 36 (3.0%) without ARI (P< 01). The mortality odds ratio, adjusted for APACHE III, ICU care, and HAI, was 2.16 with an attributable mortality rate of 6.5% or 12 excess deaths for episodes caused by ARI alone. Hospital stay was prolonged by 6.4 – 12.7 days. The medical costs attributable to ARI ranged from $18,588 to $29,069 per patient. Using the lowest estimates from the sensitivity analysis resulted in a total cost for this single hospital of $13.35 million in 2008 dollars in this patient cohort. These figures raised to $18.75 million using the highest estimates.

The authors concluded that this detailed analysis of the cost of antibiotic resistance in a single large teaching hospital express the magnitude of the problem in the United States that should lead to increased efforts to control AMR. Additionally, they suggest that this data could form the basis for a more comprehensive evaluation of the cost of resistance and the potential economic benefits of prevention programmes.

Since then, many attempts to estimate the burden of this serious public health issue have been made. It was recently suggested that ARI treatment costs have doubled since 2002[2] in the US. Excess costs were estimated to be $1,383; for the year 2014, the national cost approximates to $2.2 billion annually. A recent systematic review[3] of 214 studies found that the excess costs ranged from non-significance to $1 billion per year whilst economic burden ranged from $21,832 per case to over $3 trillion in GDP loss. These variations show that methodological assumptions and biases can occur dependent on chosen outcome and perspective. Another report[4] estimated that the total economic cost of resistance for five main pathogens (*S. aureus, E. coli, K. pneumoniae, A. baumanii* and *P. aeruginosa)* was $0.5 billion and $2.9 billion in Thailand and the US respectively. Finally, the overall AMR cost for year 2015 reached EUR 109.3 million in France with a mean of EUR 1103 per stay[5]; extrapolation to the entire National database estimated that this figure could potentially reach EUR 287.1 million if all cases would be identified. The mean excess length of hospital stay attributable to AMR was estimated at 1.6 days.

Calculating the economic costs of ARI will always be difficult due to many confounding factors and biases, but there is no doubt that the complexity and seriousness of the whole problem is a huge issue (e.g. mortality, increased hospital stay, the increase need of broad spectrum antibiotics, the lack of new treatment options for MDR bugs and costs). The concept of attributing costs to ARI was introduced by Roberts and Levy a decade ago and is one which will remain highly significant for a long time to come.

References

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