

A cost analysis estimation of a single episode of comprehensive dental treatment under general anaesthesia for adults with disabilities

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Key points

This paper provides a cost estimate for the provision of comprehensive dental treatment under general anaesthesia for adults with disabilities.

This paper used a mixed method costing analysis to account for hospital and dental costs.

This paper confirms that dental general anaesthesia for adults with disabilities is an expensive treatment modality.

Background The provision of dental treatment for adults with disabilities may require the use of general anaesthesia, provided in a hospital setting. **Aims** To estimate the costs of an episode of dental general anaesthesia (DGA) for adults with disabilities in Ireland. **Design** A mixed method cost analysis estimation using top-down and bottom-up cost estimation methods. **Setting** Dublin Dental University Hospital, Ireland. **Materials and methods** A cost estimate for dental treatment provided under GA for adult patients with disabilities from the Dublin Dental University Hospital service in 2013 was performed. A mixed method costing analysis was used. Top-down costing estimates for the general hospital costs, and bottom-up dental costing estimates, were used to produce a total cost per patient. **Results** The average cost, per patient, for day-case dental general anaesthesia for adults with disabilities was estimated as €2,242.87 (approximately £1,914.96). For cases that involved an overnight stay, an additional cost of €1,213 (approximately £1,035.66) was incurred. **Discussion** The cost estimate provided confirms that DGA in Ireland is an expensive treatment modality. The cost estimation created in this study can act as a national estimate, in the absence of a service-specific cost analysis. **Conclusions** This study demonstrates that DGA is an expensive, albeit necessary, treatment modality in Ireland.

Introduction

Approximately 90% of adults with disabilities are able to have their oral health needs met in the primary care setting, by providing minimal supports, for example, appropriate physical access, sufficient time, understanding attitudes, psychological and behavioural techniques or conscious sedation.^{1,2} For a proportion of adults with disabilities, these supports are not sufficient for the provision of good quality, safe dental care. Instead, the provision of dental treatment may require the use of general anaesthesia (GA) provided in a hospital-setting.³ Many papers cite the primary indication for

GA as 'an inability of the patient to cooperate for treatment'.⁴ However, other factors may also drive the use of GA including, but not limited to, extreme fear and anxiety,⁵ extensive treatment needs,^{3,6} prevention of negative dental experiences,⁷ where local anaesthesia is contraindicated,^{7,8} treatment of extensive trauma or odontogenic infection,⁹ and medical conditions which require a stress-reduction protocol.^{8,10} Any one or a combination of these factors may act as an indication for the use of GA for dental treatment in a specific individual.

General anaesthesia (GA) is defined briefly as 'a state of controlled unconsciousness'¹¹ or more descriptively as 'a drug-induced loss of consciousness during which patients are not arousable, even by painful stimulation. The ability to independently maintain ventilator function is often impaired. Patients often require assistance in maintaining a patent airway, and positive pressure ventilation may be required because of depressed spontaneous ventilation

or drug-induced depression of neuromuscular function. Cardiovascular function may be impaired.¹² Since the publication of the Poswillo Report in the United Kingdom,¹³ which aimed to reduce the risk of fatalities and adverse events within dental primary care settings, GA in the United Kingdom and Ireland has been mostly limited to hospital settings, with access to a critical care facility.¹⁴

It is well documented that dental general anaesthesia (DGA) is a major event for the individual patient with disabilities and their families/care staff. Waiting times for treatment,¹⁵ procedural stress, post-operative recovery time,¹⁶ and opportunity cost, for example, in terms of staffing requirements or time off work,¹⁷ have all been described as issues for adults with disabilities. For dental services, the provision of dental treatment under GA for this population has been shown to be much more costly when compared to providing the same treatment under local anaesthesia.¹⁸

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In relation to costs, the last published research into the costs of DGA for adults with disabilities in Ireland was conducted in 1995. Holland *et al.* investigated the costs involved in treating special care patients under GA in a specially designed unit in Ireland.¹⁸ The authors calculated cost per patient, based on fixed and variable costs, as IR€613 (approximately €778/£688 at current exchange rates), a value that was ten times more than the cost of the average course of routine dental treatment (IR€60/€76/£67 at current exchange rates) in Ireland at the time. There has been limited research published in the UK regarding the cost of adult DGA services. A single published study reported the average cost for a number of English services as £204-480 per patient treated.¹⁹ However, the questionnaire used did not fully report associated hospital costs, only accounting for associated dental costs.¹⁹

Background to Dental General Anaesthesia Services in Ireland

Currently, DGA for adults with disabilities is provided throughout the country in regional hospitals, in allocated theatre sessions. The DGA is provided in general theatres, which are used by numerous medical specialties throughout the week. The dental treatment is provided on a sessional basis, by dental staff normally from the Health Service Executive (HSE) Dental Services. The hospital costs, for example, anaesthetist and theatre nurses' salaries, are included in the budget of the regional hospital, whereas dental costs, for example, dentist salaries and dental supplies, are included in the HSE Dental Services budget. There are some exceptions to this, namely Our Lady's Children's Hospital, Crumlin in Dublin and Cork University Hospital; the former has a hospital-funded dental service, and the latter has a dedicated dental theatre.

Cost estimation

Approaches to estimating costs have been broadly grouped into two categories:

- Bottom-up approaches identify and specify the amount of each resource that is used to produce an individual healthcare service, and assign aggregate costs for a healthcare service²⁰
- Top-down approaches use relative value units or another metric to assign total costs for a healthcare system to individual services.²⁰

There is currently no recognised gold standard for costing methods, as both methods provide

only an estimate of true costs.²⁰ Bottom-up approaches are able to account for outliers and local variation, however, they are more costly and complex to perform. Top-down approaches are more straightforward to perform as they smooth out cost differences over time and between patients, because they apply the same weights to similar products, irrespective of time or individual. However, top-down approaches rely heavily on the quality of secondary data, which may affect sensitivity and precision. For this reason some researchers have advocated mixed methods to tailor measurements towards the cost objectives.²⁰

Background to the Irish Casemix Programme

In 1991, the Irish Casemix Programme was established, in Ireland, by the Department of Health and Children and is an international system adapted for Irish hospital systems, costs and patients.²¹ Casemix provides a means for standardising data collected on acute hospital activity and acute hospital costs, so that meaningful comparisons can be made between different areas of activity/costs and different hospitals. The Irish Casemix Programme is an example of top-down economic costing. The Casemix system works by coding hospital activity and assessing hospital costs. The exact method of coding is not currently publicly available.²¹

Irish hospital activity is coded using the Hospital In-Patient Enquire (HIPE) programme, a computer-based discharge system designed to collect demographic (age, gender, geography), clinical (diagnoses and procedures), and administrative data on discharges and deaths from 62 acute general hospitals. Using this programme, each hospital's caseload is categorised into discrete groups known as diagnostic-related groups. Currently in Ireland, the Australian Defined-Diagnostic Related Groups (AR-DRGs) version 6.0 is used, which has over 600 AR-DRGs, in 25 Major Diagnostic Categories. DRGs are medical procedures or medical diagnoses that share common clinical attributes and, therefore, are expected to receive similar treatment and consume equivalent hospital resources. These groupings provide a way for episodes of care to be categorised and assessed (Fig. 1). Surgical procedures performed are classified by the most resource intensive procedure, while medical admissions are assigned on the principal diagnosis. Complexity of the case is

recorded using variables such as the presence of complications and/or comorbidities, age or discharge status, which may influence the treatment process and subsequently the pattern of resource utilisation. Annual total cost data are collected from 39 of the 62 hospitals involved in HIPE, and costs are distributed among the cases treated, via an AR-DRG assignment and a set of cost weights. Cost weights are allocated to DRGs reflecting the relative resource consumption of one DRG to another. These are used to allocate an average cost per case for each AR-DRG, geared towards the most accurate 'costs per case' figures possible. The scope of the 'cost per case' are shown in Figure 1. Fixed and variable costs are accounted for but capital and depreciation cost, known as sunk costs, are excluded.

Within the Irish Casemix Model 'Dental Extractions and Restorations – D40Z' is a specific AR-DRG grouping, in the Major Diagnostic Criteria Group 'Diseases and Disorders of the Ear, Nose, Mouth and Throat'. This code solely refers to dental disease, with separate codes used for maxillofacial surgical procedures, salivary gland procedures and other oropharyngeal procedures.

Aims

To estimate the current costs of an episode of DGA for adults with disabilities in Ireland.

To evaluate the cost of a single episode of oral rehabilitation under GA, provided in St. Columcille's Hospital, for adult patients of the Dublin Dental University Hospital Special Care Dentistry department.

Materials and methods

Ethical approval was granted for this study by the Trinity College Dublin Research Ethics Committee. A cost estimate for dental treatment provided under GA, for adult patients with disabilities, from the Dublin Dental University Hospital (DDUH) service in 2013, was performed. This service is carried out monthly, in St. Columcille's Hospital, a general hospital that has access to critical care facilities. A mixed methods costing analysis was used. AR-DRG costing estimates for 2013 were used to estimate the general hospital costs of providing this service, while bottom-up costs of the DDUH, DGA service for 2013 were calculated, in order to produce a total cost of providing treatment for each patient.

Data collection

A data request was submitted to the Irish Casemix Programme, concerning costing for the specific AR-DRG D40Z 'Dental extractions and restorations' for 2013. The DDUH, DGA service was used as a case study, and dental costs for their DGA service were calculated. Dental costs were collected for fixed costs and variable costs as follows:

Fixed costs were calculated for equipment repair and annual servicing of equipment fees.

Variable costs were calculated for salaries of dental staff involved (direct labour), salaries of administration staff involved (indirect labour), travel costs, and costs of dental consumables. Sunk costs, such as the initial purchase of dental equipment for the hospital theatre, were not included in order to maintain consistency, as depreciation is not included in cost estimates generated from the Irish Casemix Programme.

Basic calculations were performed to create a cost estimate per patient, by adding dental costs to AR-DRG costs.

Results

The average total cost, per patient, for day-case GA for dental treatment for adult patients with disabilities from the DDUH was estimated as €2,242.87 (approximately £1,914.96 using 2013 exchange rates). For cases that involved an overnight stay, an additional €1,213 (approximately £1035.66 using 2013 exchange rates) has to be added to the estimated cost. Assumptions made in the economic evaluation are listed in Table 1, and the breakdown of the costs is detailed in Table 2. In 2013, there was a national total of 1,382 episodes of day-case DGA and 74 episodes of in-patient DGA for adults with disabilities in Ireland.²¹ Therefore, the total national cost for DGA in 2013 was an estimated €3.3 million (£2.8 million using 2013 exchange rates), using our cost estimation. This does not take into consideration patient-related costs, such as transport costs, staff costs or time off work for parents.

Discussion

The cost estimate provided confirms that DGA in Ireland is an expensive treatment modality. It is expected that the value of €2,242.87 (approximately £1,914.96 using 2013 exchange rates) is a reasonable estimate of the cost of DGA in most Irish centres. Most centres have similar staffing structures, and are providing reasonably

equivalent treatments, for similar adult populations. This means that the cost estimation created in this study can act as a national estimate, in the absence of a service-specific cost analysis. The national cost estimate of €3.3 million (£2.8 million using 2013 exchange rates) represents a substantial proportion of national annual public dental spending in 2013, estimated at €135 million (£114.80 million using 2013 exchange rates).²² This will always be a necessary service for some special care patients,³ however, the high cost service provides for a very small percentage of the population. Therefore, it is vital that the outcomes of DGA are optimal, in order to minimise the financial impact on a public health system.

The need to reduce the use of DGA has been well documented from a biopsychosocial perspective,¹⁶ with the Irish Dental Council recommending that the use of DGA should be a last resort.¹⁴ In order to reduce the need for dental treatment under GA in the population with disabilities, access to good preventive dental care as well as conscious sedation services are vital. In addition, the provision of high quality dental treatment is necessary in order to achieve optimal dental outcomes.²³

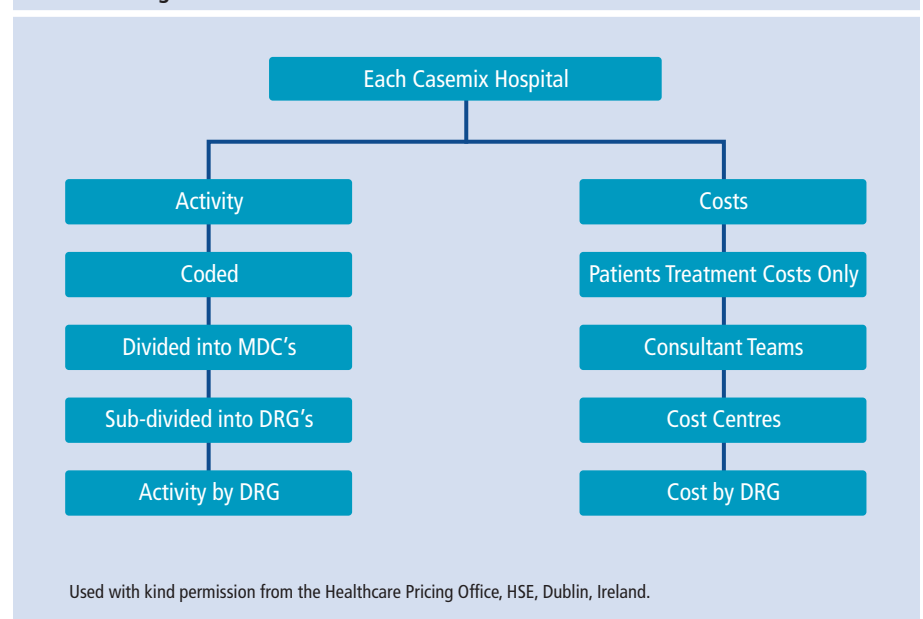
By comparing this cost estimate of DGA for adult special care patients, with the only other Irish estimate for a similar service¹⁸, it is evident that cost has greatly increased in the intervening 20 years. Holland *et al.* reported that the cost per patient in 1995 was an estimated IR€613. With inflation, this is currently equivalent to approximately €1,200/£1,024.²⁴ The increased

cost may be accounted for by increases in wages, increased use of consumables in accordance with improved infection-prevention control, increased cost of pharmaceuticals or increased use of costly technology. However, the different methods used for data collection between the two studies may account for some of the disparity. Holland *et al.*¹⁸ used a bottom-up cost analysis of services delivered in a specialised dental theatre. This method potentially underestimated cost as it did not account for general hospital overheads. A specialised dental theatre may also be more cost-efficient than the more typical use of a general theatre for the provision of DGA. Future studies into the costs of DGA in Ireland should consider this during the planning stages so that comparisons would be more meaningful. Due to the structure of Irish DGA services the comparison of costs with studies of dissimilar international DGA services, for example office-based services, may be of minimal value. However, the data from this study act as a reference for international studies of structurally similar DGA services or could be used as a cost estimate in the absence of a more accurate, national value.

Study limitations

There are a number of design considerations in this study that should be taken into account when reading the results. Firstly, this study made no account for sunk costs, such as depreciation of dental equipment. As the Irish Casemix Programme takes no account

Fig. 1 The relationship between hospital activity and hospital costs, showing how top-down costing is estimated²¹



for depreciation costs, these were not calculated for dental equipment either.²¹ Thus, the total value may be an underestimate of the actual cost. Another potential discrepancy is the use of hospital costs as supplied by the Irish Casemix Programme. These are national average values, meaning they cannot account for individual patient or individual service outliers. This may increase inaccuracy in the cost estimate as a whole. In addition, it should be noted that these values are reliant on the accuracy of the input data, and there is

currently no method of verifying the accuracy of Casemix data.²¹ Despite this, there are a number of benefits to using Irish Casemix values, such as the ability to account for the proportion of general hospital running costs used by each patient, irrespective of medical treatment received. This increases accuracy and to date, this has not been acknowledged in the dental literature. Another potential flaw in this study is the value calculated for dental materials. These data were based on the official Dublin Dental University Hospital DGA

materials budget for 2013, calculated based on the number of patients treated. However, there appeared to be anecdotal evidence to suggest that staff members are able to utilise dental materials from other areas within the dental hospital. This was common practice when some materials were used too infrequently to justify the expense of acquiring large amounts of stock, which would go out of date on a monthly DGA list. Unfortunately, accurate information regarding this practice could not be elucidated, but may have resulted in an underestimate of the cost of dental materials.

Future research

Further research is required into other aspects of costing around DGA for adults with disabilities. This should include ‘opportunity’ costs or indirect costs to the patient or families; costs incurred due to distances travelled; time off work and/or the need to employ additional care staff to take care of the patient during and after the DGA.¹⁶ Such research will help to further clarify the true cost and burden of DGA. Research should also be carried out to review inefficiencies within DGA services, such as patient cancellations on the day of surgery and inefficient use of theatre time, in order to maximise benefit to the patients and the dental service. In addition, a cost effectiveness analysis should be carried out, to compare the costs of DGA with dental treatment using other modalities, such as conscious sedation or preventive-alone regimes.

Conclusions

This study provides the first Irish estimate of DGA costs for adults with disabilities in approximately 20 years. It demonstrates that DGA is an expensive, albeit necessary, treatment modality in Ireland. The implementation of preventive programmes that reduce the need for repeated episodes of DGA, or that produce an increase in the interval between episodes of DGA, may impart economic benefit for dental services, as well as the biopsychosocial benefits documented for the individual patients. In addition, expansion of accessible, conscious sedation services as well as postgraduate training of both specialists in special care dentistry and GPs with an interest in the routine management of adults with disabilities may reduce the requirement for dental treatment under GA.

Working weeks per year	48 weeks
Working says per week	5 days
Work days (minus bank holidays/public holidays)	240 – 9 = 231 days
DGA sessions per annum	11 days
Patient treated per annum 2013	22

Irish Casemix Model Costs for D40Z ‘Dental Extractions and Restorations’ 2013		
	Cost (€)	Sterling estimate**
Daycase per patient	€1,335	£1,139.82
Overnight bed per patient	€1,213 (additional)	£1,035.66
Dental costs (direct and indirect) 2013		
Senior dentist salary	€92,437*	£78,922.71
Including 30.75% PRSI/Pension	€120,861.38	£103,191.45
Senior dental nurse salary	€50,665**	£43,257.78
Including 30.75% PRSI/Pension	€66,244.49 (× 2) = €132,488.98	£113,119.09
Overheads (est. 40% salary costs)	€101,340.14	£86,524.21
Total per annum	€354,690.50 for 231 days	
Total salary costs per patient	€767.73 per patient	£655.49
Dental consumables	€1,683.00	£1,436.95
Equipment servicing	€765.00	£653.16
Staff travel costs	€635.80	£542.16
Total per annum	€3,083	
Total dental costs per patient	€140.14	£119.65
Total per patient	€1,335 + €767.73 + €140.14	
	€ 2,242.87	£1,914.96

*Based on highest point on salary range (€79,573–€92,437), assuming ten years post-graduation experience.
 **Based on highest point on salary range (€39,929–€50,665), assuming ten years post-graduation experience.
 ***All sterling values should be treated as an estimate only as exchange rate is subject to market change. Values provided based on a 0.85 euro to sterling exchange (average 2013 value).

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