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Title:

The Cost of Universal Screening for Gestational Diabetes Mellitus in Ireland

Running Title:

The Cost of Universal Screening for GDM in Ireland

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SUMMARY

Aims

To estimate the costs associated with universal screening for gestational diabetes mellitus (GDM) in Ireland.

Methods

Bottom up, prevalence based cost analysis. Healthcare activity identified using the Atlantic Diabetes in Pregnancy (ALANTIC DIP) database was grouped into five categories: screening and testing, GDM treatment, prenatal care, delivery, and neonatal care. A vector of unit cost data (Euros in 2008 prices) was applied to specified resource use and the total healthcare cost calculated. A series of one-way and probabilistic analyses were undertaken to explore the uncertainty in the analysis.

Results

When individual resource components were valued and aggregated, the total healthcare cost of GDM in Ireland was estimated at €12,433,320 (95% CI: €9,298,228 - €16,778,193). The average cost per case detected was €1621 (95% CI: (€524 - €2,603) and the average total cost per case detected and treated was €11,903 (95% CI: €7,645- €16,121).

Conclusions

This research provides the first estimates of the healthcare costs associated with GDM in Ireland. Further research is required to determine the cost effectiveness of GDM screening in the region with a view to improving resource allocation in this area in the future.

Keywords: Gestational Diabetes Mellitus; Cost Analysis

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http://www.htai2010.org/site/

INTRODUCTION

Gestational diabetes mellitus (GDM) is defined as any degree of glucose intolerance with onset or first recognition during pregnancy and is associated with several maternal and neonatal complications (1, 2). Less in known about the economic burden of the disease; with only one cost of illness study found in the literature. That study estimated the healthcare costs of GDM in the United States of America (USA) to be $636 million in 2007 (3).

Screening practices vary within and across European countries with some offering universal screening to all pregnant women and others only to selective high risk groups. The results from Australian Carbohydrate Intolerance in Pregnant Women (ACHOIS) Study showed that active treatment of glycaemia was both an effective and cost effective strategy for women with impaired glucose tolerance and GDM (2,4). This has led to calls for a more aggressive approach to screening. In Ireland, there is no national policy on GDM screening and a debate continues as to what form such a policy should take.

In the west of Ireland, the Atlantic Diabetes in Pregnancy (ATLANTIC DIP) network provides universal testing for all pregnant women at 24-28 weeks using a 75g Oral Glucose Tolerance Test (OGTT) (5). The ATLANTIC DIP network was established in 2005 with a focus on research, audit, clinical care, professional and patient education and to provide robust information on pregnancy outcomes in women with diabetes. The network includes five hospital centres along the Atlantic seaboard which are linked using a clinical information database which captures a comprehensive range of data on maternal characteristics, outcomes for mothers and infants, and healthcare resource usage over the course of pregnancy. Ethical approval for the project was provided by the Health Service Executive Research Ethics Committee.

In this study, we combine data for a cohort of women from the database with additional data on resource use and unit costs to estimate the costs associated with screening, testing for and treatment of GDM over the course of pregnancy. We extrapolate these results to the national level to estimate the costs associated with implementing a strategy of universal screening in Ireland.

PATIENTS AND METHODS

Overview

We use a bottom-up, prevalence-based method of analysis using data from a range of regional, national and international sources. Estimates for GDM prevalence, maternal and neonatal outcomes, and healthcare resource utilisation associated with the care pathway followed were obtained from an ATLANTIC DIP dataset and extrapolated using national statistics for the annual number of eligible pregnancies. It was assumed for the base-case analysis that prevalence among women who did not participate in testing was equal to that observed among those who were tested. Furthermore, a distinction was made between women whose condition was detected and treated and women who, having declined testing, went undetected and untreated. To reflect expected differences in mode of delivery and neonatal admissions across detected and undetected cases, observed utilisation rates for a combined sample of negative tested cases and non participants in the screening programme were adopted to cost the latter. This approach assumes that the selected group is representative of the general population of pregnant women and that mode of delivery and neonatal care for undetected cases follows that of the general population.

The episode of care to which the cost analysis related covered the period from screen offer until discharge following delivery. Activities were examined under five headings: (i) screening and testing, (ii) GDM treatment, (iii) prenatal care, (iv) delivery care, and (v) neonatal care. The cost per individual activity was estimated, totalled and all costs aggregated to provide an estimate of the total cost of care which was then extrapolated to the national level. Resource use was identified from a variety of sources including interviews with consultants at representative ATLANTIC DIP centres, published national data and, when necessary, published UK data sources. In cases where UK treatment protocols were adopted, these were reviewed by the study clinicians to ensure that they were applicable to the Irish setting. A vector of unit costs was applied to estimate the cost associated with each activity. Unit cost data were obtained from national sources, and where necessary UK sources. Where the latter were used they were transformed into Euros in 2008 prices using appropriate inflation and exchange rate indices (6,7). A series of one-way and probabilistic analyses were undertaken to explore the uncertainty in the analysis.

Costing Methodology

The approach taken to cost each individual healthcare activity is detailed below and in Table 1 with further information provided in the appendix.

(i) Screening and Testing

We assume that all eligible pregnant women were offered testing. The annual number of singleton pregnancies in Ireland in 2008 was obtained from the Central Statistics Office (8). Women with a multiple births were excluded from the analysis because the small numbers involved would make it difficult to calculate the additional cost attributable to diabetes in a robust manner. Furthermore, pregnancies where screening would not be offered due to the existence of prior complications (20% of total pregnancies) were excluded from calculations as these cases would already be under surveillance (9). The cost per screen offer was estimated at €3.65, on the basis of a fifteen minute phone call by clinic secretarial staff to inform and invite a woman for a diagnostic test.

Data on screen uptake were obtained from an ATLANTIC DIP dataset, comprising observations on 9,043 pregnant women. Of the total offered screening, 58% or 5,218 women participated in testing. Testing comprised a 75g OGTT, at an estimated cost of €35.20 per test. This included the costs of clinician time input, test sample materials and laboratory analysis.

(ii) GDM Treatment

Prevalence in the participant group in ATLANTIC DIP was 2.6% (*Criteria:* fasting blood glucose >/= 7 mmol/l and/or 2h post glucose load of >/=11.1 mmol/l). For the analysis, this prevalence rate was applied to both participants and non participants in the screening programme. This assumption was made in the absence of data on the actual number of GDM cases within the non participant cohort.

Treatment for detected cases of GDM included lifestyle intervention and blood glucose self monitoring. In costing the lifestyle intervention, we assumed that all women attended a consultation with a dietician and two consultations with a diabetes nurse specialist (consistent with the treatment protocol operated in the ATLANTIC DIP). The estimated cost of lifestyle intervention was €205 per case, based on the cost of the nurse time input. In costing self monitoring, we assumed that all cases self-monitored for an average of twelve weeks, testing their blood sugar level on average four times per day. The combination of lancets, strips and blood glucose meter for a standard case were adopted from a UK study (9), giving an estimated cost €144.20 per case. In addition, women who did not respond to lifestyle intervention after two weeks were prescribed insulin for the remainder of their pregnancy. The numbers in this category were identified from the study. We assumed that such women received treatment for an average of 90 days. The size, frequency and length of dosage were adopted from a UK study (9) and unit costs for the most commonly prescribed regular insulin and rapid-acting insulin analogues Lispro and Aspart in Ireland were obtained from the Monthly Index of Medical Specialities (10). The average cost of insulin was estimated at €115.07 per case treated.

(iii) Prenatal Care

In respect of prenatal care, data on utilisation of services for both GDM and non-GDM pregnancies were provided by consultants at University College Hospital Galway, a representative ATLANTIC DIP centre. Prenatal care for detected cases was provided in multi-disciplinary clinics by specialists in diabetes and obstetrics. Prenatal care for undetected cases was assumed to follow that of a non-GDM pregnancy. The estimated costs of prenatal care per case were €3195 for GDM cases and €1585 for non-GDM/unidentified GDM cases, based on the specified usage of outpatient clinic consultations, ultrasound scans, and primary care consultations.

(iv) Delivery Care

Mode of delivery was recorded as normal vaginal delivery (NVD) or caesarean section (CS) (no distinction was made between emergency and elective CS). For undetected GDM cases, the observed rates for the combined group of negative tested cases and non participants in the screening programme for CS and NVD were adopted. The respective rates for detected versus undetected cases were 43% and 76% for NVD, and 57% and 24% for CS. The cost per mode of delivery was estimated as the weighted average of all diagnosis related groups (DRG) per mode (weighted on the basis of the number of cases per DRG) in the Health Service Executive Casemix database (11). Estimates of €2373 per NVD case and €5765 per CS were adopted for the analysis.

(v) Neonatal Care

All admissions of infants born to women with GDM to neonatal intensive care were recorded in the database. For undetected cases, the observed rates for neonatal admission for the combined group of negative tested cases and non participants in the screening programme were adopted. The respective rates for detected versus undetected cases were 39% and 11%. The weighted average cost (€7115) across all neonatal DRG admission categories (11) was adopted for the analysis.

Sensitivity Analysis

A series of one-way sensitivity analyses were undertaken to explore the uncertainty in the base-case analysis. First, of the total number of women offered testing, 58% took up the offer. We explore alternative participation rates of 50%, 65%, 80%, 90% and 100%. Second, as prevalence was estimated for a sample of women in the west of Ireland, it may be the case, given the region's socio-economic and ethnic make-up, that national prevalence is greater. We adopt the estimated prevalence rate for England and Wales of 3.5% (9). Third, as detailed in Table 2, differences existed across the characteristics of participants and non participants in the screening programme. As a result, there is a possibility of selection bias among the participating group in terms of disease prevalence. We explore the impact of assuming hypothetical higher (5%) and lower (1%) prevalence rates for the non participant group. Fourth, we assumed that the sensitivity and specificity rates for the 75g OGTT were both 100% (9). We explore the impact of individually reducing both sensitivity and specificity rates to 50%. We also re-estimate results for assumed rates for sensitivity and specificity of 86% and 80% respectively, as adopted in a previous US study (1). Finally, observed rates for a combined sample of negative tested cases and non participants were adopted to cost undetected cases. This approach may be considered conservative as it assumes that undetected cases are equivalent to the general population. In sensitivity analysis, we test a potentially upper bound estimate whereby observed rates for detected cases from the ATLANTIC DIP were adjusted using data from the ACHOIS study (2). The respective rates tested for NVD, CS and neonatal admission for undetected cases were 40%, 60% and 34%.

In addition, uncertainty was explored using probabilistic methods (12,13), whereby input parameters were assigned appropriate probability distributions and a Monte Carlo simulation process was undertaken to generate 1,000 replications of the total cost results. This enabled the estimation of 95% confidence intervals for the total cost estimates.

RESULTS

The results from the base-case analysis are presented in Tables 3. From an annual total of 65,579 singleton pregnancies, 52,463 women were deemed eligible for a test offer. The total cost of offering a test to all eligible women was estimated at €191,490. Assuming an offer acceptance rate of 58%, it was estimated that 30,429 women would both accept and attend for testing at a total cost of €1,071,086. The impact of increasing screening uptake rates to 65%, 80%, 90% and 100% would be to increase the total costs of testing to €1,204,049, €1,477,360, €1,662,031 and €1,846,701 respectively.

Assuming a prevalence rate of 2.6%, universal screening would identify 779 positive cases, at a total cost of €1,262,577 and an average cost of €1,621 per case detected. The total cost of treating detected GDM cases was estimated at €159,689 for lifestyle intervention, €112,328 for self monitoring and €38,544 for insulin, to which 43% or 335 women were prescribed. Furthermore, the total cost of prenatal care for detected GDM cases was estimated at €2,488,815. In respect of delivery, 57% or 443 women who receive appropriate treatment for GDM were predicted to have CS, with the remaining 43% or 336 women having a NVD, at estimated total costs of €2,555,250 and €764,704 respectively. Of total live births to women treated for GDM, 39% or 272 infants were predicted to experience a neonatal intensive care unit admission at an estimated total cost of €1,938,261.

For the 42% or 22,034 women who did not participate in testing, 2.6% or 564 were predicted to have GDM which would go undetected and untreated. The total cost of prenatal care in this cohort was estimated at €894,072. Furthermore, 76% or 429 women with undetected GDM were predicted to have had a NVD with the remaining 24% or 135 women having a CS, giving total costs of €1,017,313 and €780,465 respectively. Of total live births, 10% or 55 infants were predicted to experience a neonatal intensive care admission, resulting in a total cost estimate of €389,305 for this cohort.

When individual resource components were aggregated, the total healthcare cost associated with GDM in Ireland was estimated at €12,433,320 (95% CI: €9,298,228 - €16,778,193). This includes the total costs of care for detected cases, estimated at €9,271,740 (95% CI: €5,955,741 - €12,558,517) and undetected cases, estimated at €3,161,580 (95% CI: (€2,096,192- €5,395,352). The total cost per case detected and treated was €11,903 (95% CI:

€7,645- €16,121). This compares to the total cost per undetected and untreated case of €5,605 (95% CI: €3,716- €9,565).

The results from the one-way sensitivity analyses are presented in Table 4. The effect of increasing uptake rates was to increase the total cost of care relative to the base-case analysis, whereas a reduced uptake rate led to reduced costs. Increasing prevalence rates led to increases in the total cost estimates while reducing the prevalence rate for non participants led to a reduction in cost. Reducing the assumed sensitivity and specificity of the 75g OGTT to 50% led to an increase and decrease in the total cost estimate respectively. The effect of assuming respective sensitivity and specificity rates of 86% and 80% led to an increase in the total cost estimate. Finally, adopting upper bound estimates for NVD, CS and neonatal admission for undetected cases led to an increase in the total cost of care.

DISCUSSION

This study provides the first estimates of the healthcare costs associated with GDM in Ireland. We present estimates in terms of a national universal screening programme, in the form of that provided by the ATLANTIC DIP network. The projected total healthcare cost of GDM over the course of pregnancy in Ireland was estimated at €12,433,320 (95% CI: €9,298,228 - €16,778,193). The projected total cost of screening and testing was estimated at €1,262,577 (€407,959 - €2,027,816). The projected total cost of detecting and treating a positive case was estimated at €11,903 (95% CI: €7,645 - €16,121), which would represent an additional expenditure of approximately €6,300 over the equivalent undetected and untreated case. This can be compared to the results of Chen et al (3) who estimate that GDM increases the medical cost of pregnancy by an average of $3,305 in the USA. Importantly, we made no attempt to monetise the adverse outcomes experienced by mothers and infants which result from untreated GDM or the improved quality of life associated with the provision of appropriate care (2). To address the broader issue of the cost effectiveness of universal screening, further research is required to relate the costs to the benefits which would result, both in terms of maternal and neonatal outcomes, from the identification and appropriate treatment of GDM (2). Moreover, these outcomes should be compared to those from the alternative available screening models which could be introduced. For example, recent NICE guidance in the UK recommends that GDM screening be targeted at specific high risk groups (9).

The results from the sensitivity analysis indicate that increasing screening uptake rates would increase the costs of care, primarily as a result of the additional costs of testing and treatment for newly detected cases. As expected a higher overall prevalence rate led to increased costs. Potential selection bias with respect to screening participation was examined by assuming different prevalence rates for non participants. Higher and lower rates were examined as it was unclear whether non participants were at higher or lower risk than participants. Increasing the prevalence rate led to an increase in the total costs of care due to the additional costs associated with the care of undetected GDM cases. As expected, reducing the prevalence rate led to a reduction in total costs. While the 75g OGTT is deemed to have high sensitivity and specificity (9), the effect of varying these rates was examined. A reduced sensitivity rate of 50% led to an increase the projected number of GDM cases to be included in the analysis, leading to an increase in the total costs of care. Conversely, a reduced specificity rate of 50% led to a decline in the projected number of GDM cases and a reduction in total costs. An analysis assuming sensitivity and specificity rates of 86% and 80% respectively showed an overall increase in total cost. Finally, adjusting utilisation rates using data from the ACHOIS study led to an increase in the total cost of care for undetected GDM cases.

There were a number of limitations in the analysis which relate directly to the assumptions adopted. Firstly, while we explore the impact of varying prevalence rates for non participants in sensitivity analysis, it is unclear whether the assumptions adopted in the analysis are appropriate in the absence of data on the actual number of GDM cases within this cohort. Secondly, the applicability of utilisation rates for the combined sample of negative tested cases and non participants in the costing of care for undetected GDM cases is open to question. Nonetheless, we believe this sample to be representative of the general population of pregnant women as it includes both actual and potentially negative cases as well as potentially positive cases not identified and treated for GDM. Thirdly, our results are likely to underestimate the total cost of GDM, as we exclude healthcare resource utilisation post hospital discharge, private out-of-pocket expenses to the woman and her family, and additional losses to broader society. Furthermore, we make no attempt to monetize the adverse effects of GDM on the health of either mother or infant. This is particularly relevant for women with GDM who do not receive appropriate treatment. Moreover, in applying the adopted GDM classification criteria we exclude from the analysis women with impaired glucose tolerance. Fourthly, the process of conducting cost analysis in Ireland is complicated by the lack of nationally available healthcare utilisation and unit cost data. In some cases we adopted equivalent UK data to detail the process and cost of the treatment as Irish data were not readily available. While this is not ideal, appropriate adjustments were made and we endeavoured at all times to be conservative in the assumptions adopted.

Conclusion

This study provides estimates of the healthcare costs associated with universal screening for GDM in Ireland. To address the broader issue of cost effectiveness, a comprehensive economic evaluation is required to compare universal screening to the alternative available screening models which could be introduced in the Irish setting. The current analysis provides information useful to future research that examines this question, further it contributes to the international literature on costs of GDM by providing data on these as they arise in an Irish setting.

DECLARATION OF COMPETEING INTERESTS

Nothing to declare

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Table 1 – Cost per Activity Estimates (Euros 2008 prices)

Variable	Estimated Costs (€) Mean (SD)	Source
Screening and Testing		
Test Offer	3.65 (1.46)	Study Estimate (see Appendix)
75g OGTT	35.20 (14.08)	Study Estimate (see Appendix)
GDM Treatment		
Lifestyle Intervention	205.00 (82)	Study Estimate (see Appendix)
Insulin	115.07 (46)	Study Estimate (see Appendix)
Blood Glucose Monitoring Equipment	144.20 (58)	Study Estimate (see Appendix)
Prenatal Care:		
Positive GDM Case	3195.00 (1278)	Study Estimate (see Appendix)
Non GDM Case	1585.00 (634)	Study Estimate (see Appendix)
Delivery		
Vaginal Delivery	2373.00 (949)	DOHC, Ireland
Caesarean Section	5765.00 (2306)	DOHC, Ireland
Neonatal Care	7115.00 (2846)	DOHC, Ireland

GDM – Gestational Diabetes Mellitus; OGTT – Oral Glucose Tolerance Test

Table 2 – Baseline Characteristics of ATLANTIC DIP Cohort

Variable	Participant N=5218	Non Participant N=3825	Statistical Test (p-value)
Age – Mean (Standard Deviation)	32.96 (5.384)	32.03 (6.037)	<0.000*
Ethnic Group – No. (%) Caucasian	4855 (93.6)	3628 (94.9)	0.012*
Primiparous – No. (%)	2674 (51.2)	2036 (53.2)	0.064
Parity – Mean (Standard Deviation)	0.95 (1.139)	1.13 (1.253)	<0.000*
Body Mass Index – Mean (Standard Deviation	27.01 (5.388)	25.54 (4.905)	0.014*
Family History of Diabetes – No. (%)	1600 (30.7)	634 (16.6)	<0.000*

Note: Chi-sq tests for dichotomous variables/ t-tests for continuous variables
*Note: * denotes result that was statistically significant at the 5% level*

Table 3 – Base-Case Analysis Results (Euros 2008 prices)

Category	Source Category	% of Cases	No. of Cases
Eligible Cases	-	100%	52463
Screen Offer: Uptake/Refusal	Eligible Cases	58% / 42%	30429/22034
GDM Cases: Detected/Undetected	Eligible Cases	2.6%	779/564
Live Births: Detected GDM Cases/ Undetected GDM Cases	GDM Cases	91% / 97%	706/547
COST ANALYSIS	**Source Category (%)**	**Total Cost (€)**	**Cost/Case (€)**
Screening and Testing	Eligible Cases		
Test Offer	100%	€191,490	
SCREENING PARTICIPANTS	Eligible Cases		
Testing (75g OGTT)	58%	€1,071,086	
Cost of Screening and Testing (95% CI's)		**€1,262,577** (€407,959 - €2,027,816)	
Cost per Case Detected (95% CI's)	Detected GDM Cases		**€1621** (€524 - €2,603)
GDM Treatment	Detected GDM Cases		
Lifestyle Intervention	100%	€159,689	
Blood Glucose Monitoring	100%	€112,328	
Insulin	43%	€38,544	
Prenatal Care	Detected GDM Cases		
	100%	€2,488,815	
Delivery Care	Detected GDM Cases		
Vaginal Delivery	43%	€796,704	
Caesarean Section	57%	€2,555,250	
Neonatal Care	Live Births: Detected GDM Cases		
	39%	€1,938,261	
Cost of Detected and Treated Cases (95% CI's)		**€9,271,740** (€5,955,741- €12,558,517)	**€11,903** (€7,645- €16,121)
SCREENING NON-PARTICIANTS	Eligible Cases		
	35%		
Prenatal Care	Undetected GDM Cases		
	100%	€894,072	
Delivery Care	Undetected GDM Cases		
Vaginal Delivery	76%	€1,017,313	
Caesarean Delivery	24%	€780,465	
Neonatal Care	Live Births:Undetected GDM Cases		
	10%	€389,305	
Cost of Undetected and Untreated Cases (95% CI's)		**€3,161,580** (€2,096,192- €5,395,352)	**€5,605** (€3,716- €9,565)
TOTAL COST (95% CI's)		**€12,433,320** (€9,298,228 - €16,778,193)	

GDM – Gestational Diabetes Mellitus; OGTT – Oral Glucose Tolerance Test

Table 4 – Sensitivity Analysis Results (Euros 2008 prices)

Sensitivity Analysis	**Total Cost (€)** (95% CI)	**Cost (€): Detected and Treated Cases** (95% CI)	**Cost (€): Undetected and Untreated Cases** (95% CI)
Screen Uptake Rate 50%	**€11,756,665** (€9,255,503 - €16,971,481)	**€7,992,879** (€5,176,939– €11,690,207)	**€3,763,786** (€2,503,307- €6,721,550)
Screen Uptake Rate 65%	**€13,042,310** (€9,549,958 - €17,586,716)	**€10,422,715** (€6,196,023 - €13,227,229)	**€2,619,595** (€2,042,360 - €5,443,519)
Screen Uptake Rate 80%	**€14,294,121** (€9,659,629 - €18,691,593)	**€12,788,607** (€7,425,657 - €16,253,891)	**€1,505,514** (€1,246,353 - €3,192,257)
Screen Uptake Rate 90%	**€15,139,940** (€9,719,131 - €19,860,732)	**€14,387,183** (€8,522,907 - €18,696,075)	**€752,757** (€627,092 - €1,621,873)
Screen Uptake Rate 100%	**€15,985,759** (€9,272,910 - €21,263,520)	**€15,985,759** (€9,272,910 - €21,263,520)	**€0** (n/a)
Non Participant Prevalence Rate 5%	**€15,370,045** (€11,184,023 - €20,688,016)	**€9,271,740** (€5,428,351 - €12,022,613)	**€6.098,305** (€3,840,308 - €10,539,121)
Non Participant Prevalence Rate 1%	**€10,555,742** (€6,732,103 - €13,419,840)	**€9,271,740** (€5,492,045 - €12,566,729)	**€1,284,002** (€790,953 - €2,084,482)
Prevalence Rate 3.5%	**€16,535,078** (€12,020,516 - €23,121,307)	**€12,242,136** (€6,623,265 - €15,778,640)	**€4,292,942** (€3,495,364 - €9,545,294)
75g OGTT Sensitivity Rate 50%	**€19,769,402** (€14,399,682 - €27,484,666)	**€9,271,740** (€5,810,603 - €12,299,540)	**€10,497,662** (€6,557,226 - €17,282,070)
75g OGTT Specificity Rate 50%	**€10,892,743** (€8,243,614 - €15,453,124)	**€9,271,740** (€6,466,274 - €13,532,091)	**€1,621,003** (€1,032,044 - €2,626,207)
75g OGTT: Sensitivity Rate 80% / Specificity Rate 86%	**€13,469,175** (€9,742,720 - €17,696,302)	**€9,271,740** (€5,461,314 - €12,015,553)	**€4,197,435** (€2,739,908 - €7,300,111)
ACHOIS Data	**€14,048,144** (€8,817,460 - €16,979,080)	**€9,271,740** (€5,416,224 - €12,613,786)	**€4,776,404** (€2,105,968 - €5,621,315)

OGTT – Oral Glucose Tolerance Test

APPENDIX - Costing Methodology

1.1 Screening and Testing for Gestational Diabetes

The offer process involved contacting, informing and inviting the individual for a test. The cost per offer (phone call and 15 minutes of clinic secretarial time) is estimated at €3.65 (Table 1). The cost per 75 OGTT included clinician time, test materials and laboratory analysis and is estimated at €35.20 (Table 2). We assume that the 75 g OGTT has a sensitivity and specificity of 100%; in other words that no false-positive or false-negative results will be obtained.

Table 1 – Cost per Offer

Resource Item	**Number of Items**	**Unit Cost €**	**Mean Cost (SD) €**
Phone Call	1 call	€0.50 per call *EIRCOM*	0.50
Secretarial Time	15 minutes	€12.60 per hour *Irish Jobs.ie*	3.15
Total			**€3.65 (1.46)**

SD = Standard Deviation

Table 2 - Cost per 75g OGTT

Resource Item	**Number of Items**	**Unit Cost €**	**Mean Cost (SD) €**
Glucose Load	Per Test	€2.50 Per Test *ATLANTIC DIP*	2.50
Blood Bottles	Per Test	€1.50 per item *ATLANTIC DIP*	4.50
Laboratory Analysis	Full Blood Count	€18 Per Test *HSE*	18
Phlebotomist Time	15 minutes	€20 per hour *HSE*	5.01
Nurse Time	15 minutes	€21 per hour *HSE*	5.18
Total			**€35.20 (14.08)**

Source: ATLANTIC Diabetes in Pregnancy (DIP); Health Service Executive (HSE)
SD = Standard Deviation

1.2 Treatment for Gestational Diabetes

We assume that all positive GDM cases received lifestyle intervention and undertook self monitoring using blood glucose monitoring equipment. Those for whom lifestyle intervention was deemed ineffective were treated with insulin.

In costing the lifestyle intervention, we assume that all women attend one consultation with a dietician and two consultations (2nd for dietary review) with a diabetes nurse specialist. The cost of lifestyle intervention is estimated at €205 (Table 3).

Table 3 - Cost of Lifestyle Intervention for treatment of gestational diabetes

Resource Item	**Number of Visits**	**Unit Cost** **€**	**Mean Cost (SD)** **€**
Diabetic Specialist Nurse Consultation	2	€85 per consultation *HSE*	€170
Dietician Consultation	1	€35 per consultation *HSE*	€35
Total			**€205 (82)**

Source: Health Service Executive (HSE); SD = Standard Deviation

In costing self monitoring, we assume that all positive cases self-monitor for an average of 12 weeks, testing their blood sugar level on average four times per day. The combination of lancets, strips and blood glucose meter and the unit costs for these resource items were adopted from a UK study (9) and were transformed to Euros in 2008 prices using appropriate inflation (6) and exchange indices (7). The cost of self monitoring is estimated at €144.20 (Table 4).

Table 4 - Unit cost of blood glucose monitoring

Resource Item	**Unit Cost** **€**	**Mean Cost (SD)** **€** **(for 12 weeks of monitoring)**
Lancets	€7.16 for 200 *NICE (3)*	€14.32
Testing strips	€17.54 for 50 *NICE (3)*	€122.81
Blood glucose meter	€7.07 per meter *NICE (3)*	€7.07
Total		**€144.20 (46)**

Source: National Institute of Clinical Excellence (NICE); SD = Standard Deviation

In costing insulin therapy, we assume that all women received treatment for an average of 90 days. The size, frequency and length of dosage were adopted from a UK study (9). The unit costs for the most commonly prescribed regular insulin and rapid-acting insulin analogues lispro and aspart were obtained from the Monthly Index of Medical Specialities (MIMS) Ireland. The cost of insulin is estimated at €115.07 (Table 5).

Table 5- Unit cost of insulin or insulin analogue for treatment of gestational diabetes

Drug	**Dose**	**Unit Cost €**	**Mean Cost (SD) € (for 90 days of treatment)**
Regular insulin	10 units three times per day for 90 days	*MIMS Ireland*	€124.67
Insulin aspart	10 units three times per day for 90 days	*MIMS Ireland*	€112.67
Insulin lispro	10 units three times per day for 90 days	*MIMS Ireland*	€107.86
Total (Average)			**€115.07 (57)**

Source: Monthly Index of Medical Specialities (MIMS) Ireland; SD = Standard Deviation

1.3 Prenatal Care - Healthcare System Contacts

Pregnant women regularly attend prenatal care services over the course of their pregnancy. Evidence on healthcare resource usage for both GDM and non-GDM pregnancies was provided by consultants at University College Hospital Galway, which is a representative ATLANTIC DIP centre. The healthcare resource use, unit cost and total cost of care are provided in Table 6 for GDM cases and in Table 7 for non-GDM cases. Prenatal care for the former is estimated at €3195 and for the latter is estimated at €1585.

Table 6 - Cost of Healthcare System Contacts For Women With Gestational Diabetes

Resource Item	**Number of Contacts**	**Unit Cost €**	**Mean Cost (SD) €**
Diabetes Consultant Outpatient Visits	6	€160 per consultation *HSE*	€980
Obstetric Consultant Outpatient Visits	5	€160 per consultation *HSE*	€800
Specialist Diabetic Nurse Care	11	€85 per consultation *CODEIRE*	€935
Ultrasound Scans	3	€160 per scan *HSE*	€480
Total			**€3195 (1278)**

Source: Health Service Executive (HSE); (CODEIRE)The Cost of Treating Type 2 Diabetes in Ireland; SD = Standard Deviation

Table 7 - Cost of Healthcare System Contacts For Women Without Gestational Diabetes

Resource Item	Number of Contacts	Unit Cost €	Mean Cost (SD) €
Obstetric Consultant Outpatient Visits	3	€160 per consultation *HSE*	€480
Midwifery Care	7	€85 per consultation *HSE*	€595
Ultrasound Scans	1	€160 per scan HSE	€160
GP Visits	7	€50 per consultation ORC	€350
Total			**€1585 (634)**

Source: Health Service Executive (HSE): Office of Revenue Commissioner Report (ORC); SD = Standard Deviation

1.4. Mode of Delivery

We categorise mode of delivery for infants of women with GDM into vaginal delivery and caesarean section. The cost per mode of delivery is estimated as the weighted average across all diagnosis related group (DRG) categories per mode. The estimated cost per mode of delivery is shown in Table 8.

Table 8 – Cost per Mode of Delivery

Resource Item	Weighted Average Cost (€)	Standard Deviation
Vaginal Delivery	€2373	€949
Caesarean Section	€5765	€2306

Source: Health Service Executive (HSE)

1.5. Neonatal Care

Infants of women with GDM should be kept with their mothers unless there is a clinical complication or there are abnormal clinical signs that warrant admission for intensive or special care (7). The ATLANTIC DIP provides data on admissions for infants of women with GDM to the neonatal ward. The cost per neonatal admission is estimated as the weighted average across all neonatal DRG admission categories he estimated cost per neonatal admission for infants of women is shown in Table 9.

Table 9 - Cost per Neonatal Admission For Infants Of Women With Gestational Diabetes

Resource Item	Weighted Average Cost (€)	Standard Deviation
Neonatal Admission	€7115	€2846

Source: Health Service Executive (HSE)

1.5. ACHOIS Outcome Data

As a substantial proportion of women declined or accepted and failed to attend for testing, there will be a cohort of women with GDM who are not identified as being at risk and will not be treated accordingly. While this will result in cost savings in the short term arising from avoided treatment expenditures, there will be longer term effects in terms of adverse outcomes and the healthcare resource implications which result. In particular, we focus the healthcare resources relating to delivery and neonatal care. To reflect the differences in women with GDM who are and are not treated for GDM, we adjust the observed data for treated GDM cases using data from the Australian Carbohydrate Intolerance Study in Pregnant Women (ACHOIS) Study (2). The ACHOIS study was a randomised controlled trial examining the efficacy of treatment for GDM and impaired glucose tolerance in Australia. Data for elective caesarean sections, emergency caesarean infections, and neonatal admissions were adopted from ACHOIS as a measure of effectiveness of treatment for GDM versus non treatment. The observed rates from the ATLANTIC DIP for caesarean sections, vaginal deliveries, and neonatal admissions were adjusted using this data to reflect the fact that women, if positive for GDM, did not receive treatment. An important assumption in this regard is that the treatment regime in Ireland reflects that of Australia. This process is outlined in detail in Table 10.

Table 10 – ACHOIS Outcome Probabilities

Variable	**Treatment Value (TV)**	**Non Treatment Value (NTV)**	**Difference** (DIF)= ((NTV-TV) /TV)	**ATLANTIC DIP** (DIP)	**Adjusted** =DIP*(1+DIF)
Caesarean Section	0.300	0.315	0.05	57%	60%
Vaginal Deliveries	n/a	n/a	n/a	43%	40%
Neonatal Admission	0.706	0.613	-0.13	39%	34%

Source: Australian Carbohydrate Intolerance Study in Pregnant Women Study (ACHOIS)(2); National Institute of Clinical Excellence: NICE (7)

1.6 Probabilistic Analysis

Uncertainty associated with the input parameter data is addressed through probabilistic sensitivity analysis. This process involved three steps: Firstly, input parameters in the analysis were assigned appropriate probability distribution. The nature of data used in health economic analysis is such that only a relatively small number of alternative distributions are available (13). These include beta distributions for those parameters which are bounded by an interval between 0 and 1, such as probability. In addition, normal or Gaussian distribution, or alternatively, if the original data is skewed, Gamma or lognormal distributions may be assigned to represent resource use and unit cost data. Table 11 outlines the probability distributions assumed for each parameter in the probabilistic analysis. In respect of unit costs, a Gaussian distribution was specified. In cases where no information was available on the variance of the unit cost, a coefficient of variation equal to 0.40 was used to relate the variance to the mean value. Although 0.40 is an arbitrary value, it was chosen to give quite a large variance, and therefore, vague prior for the unit cost parameter. In respect of resource use, a beta distribution was specified in cases where resource use was modelled using probabilities. The beta distribution, using the methods of moments approach, was also used employed to model uncertainty surrounding data from the ACHOIS study. The second stage of the probabilistic analysis was to propagate the uncertainty for all of the input parameters through the model simultaneously. This process was undertaken using Monte Carlo simulation which re-runs the model a large number of times, with each simulation involving a random draw for a value from each of the input parameter distributions. This process generated a large number of cost results which reflect the combined parameter uncertainty in the analysis. The Monte Carlo simulation was set to 1,000 for the probabilistic model, effectively replicating the analysis 1,000 times. The third step was to present the simulated results in an appropriate format. In this case, the probabilistic model generated 1,000 data points which were used to estimate 95% confidence intervals around the cost estimates of interest.

Table 11: Probabilistic Sensitivity Analysis

Variable	Selected Distribution
Unit Costs	Gaussian
Resource Use Data – Probability of Event	Beta
ACHOIS Data	Beta