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Costs of surviving meningococcal disease in Spain: Evaluation for two cases of severe meningitis and septicaemia

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ABSTRACT

Objectives: The aim of this study was to count the lifelong rehabilitation costs associated with surviving meningococcal disease with major sequelae from the perspective of the Spanish National Healthcare System (NHS) and the national government.
Methods: Two severe scenarios describing meningococcal disease were developed, one case that represented meningococcal septicaemia and another case for meningococcal meningitis. The scenarios were developed based on a literature review on severe sequelae of meningococcal disease, and discussions with paediatricians who have been responsible for the treatment of children with this disease in Spain. Second, a detailed list of all health, educational and social care resources used by survivors during their acute illness and during the rest of their lives and by family members was obtained by interviewing survivors and their families. Professionals in health and social care were also interviewed to complete the list of resources and ensure the scenario's were accurate. The costs attributed to these resources were obtained from tariff lists, catalogues and published information by the national authorities. All costs were based on a life expectancy of a survivor of 70 years and expressed in EUR 2012.
Results: In this study it was estimated that the lifelong discounted rehabilitation costs associated with the treatment of long-term sequelae due to meningococcal disease are approximately €1180,000–€1400,000. Medical care and social care were the main cost drivers for both septicaemia and meningitis. Annual costs showed to be the largest in the first year after diagnosis of the disease for both cases, due to high hospital admission and medical care costs during this period and decreased significantly over the years.
Conclusion: This study shows that the lifelong rehabilitation costs associated with the survival of meningococcal disease with severe sequelae place an important burden on the NHS budget and governmental resources in Spain.

1. Introduction

Meningococcal disease is caused by the microorganism *Neisseria meningitidis*, a bacterium that usually colonises the nasopharynx asymptomatically but occasionally can invade the host causing meningococcal septicaemia or meningitis [1]. The incidence of meningococcal disease in Spain was estimated at approximately 0.96 per 100,000 inhabitants in the period 2009–2010 and 70% of the cases were caused by an infection of the bacterium with serogroup B [2]. Most of the patients with meningococcal disease survive relatively unscathed, but some patients are left with severe long-term sequelae and disability [3].

Sequelae associated with surviving meningococcal disease depend on the type of infection that occurred and can include limb loss (3% of patients), growth plate damage, renal failure, skin necrosis/scarring and pain (21–28% of patients) for septicaemia [3–6]. Sequelae associated with meningitis include mental disability, neurological sequelae (7% of patients) such as seizures, motor impairment, hydrocephalus, loss of vision and hearing loss (4% of patients) [3,7].

Several studies have been identified [3,8,9], two in Spain and one in the United Kingdom, that evaluated the costs associated

Abbreviations: (NHS), Spanish National Healthcare System; (INE), Spanish National Statistics Institute; (PICU), Paediatric Intensive Care Unit.

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with meningococcal disease or with one of the manifestations of meningococcal disease. The study by Iñigo et al. [8] evaluated the associated hospitalisation costs of severe sepsis in the region of Madrid in Spain for the year 2001. They showed that hospitalisation costs summed up to approximately €10.000 per case of severe sepsis. In another study performed by Gil Prieto et al. [9] it was observed that the overall hospitalisation costs per patient with meningococcal disease came to €4918 and the average annual hospitalisation costs summed up to €592,980 in the region of Madrid over the period 1997–2005. To date only one study has been identified that counted the lifelong rehabilitation costs of surviving meningococcal disease [3]. This study was performed in the UK and showed that surviving meningococcal disease with major sequelae is associated with an important burden for the NHS and government. Accurate data on the costs-of-illness of meningococcal disease is fundamental for health economic evaluations as cost-effectiveness analyses and immunisation programmes. On its turn an increase in analyses on immunisation programmes has been observed in Spain [10,11]. Although there has been an improvement in the methodological quality of studies it is clear that the existence of a huge gap in this kind of work compared to other countries [10,11].

Lifelong rehabilitation costs in the UK were shown to vary between approximately £1360,000 and £1720,000 for a survivor with severe sequelae due to sepsis and meningitis [3]. The major sequelae associated with surviving meningococcal disease are also associated with an important loss of quality of life [5,6]. Up to date no studies on the lifetime rehabilitation costs associated with surviving meningococcal disease with major sequelae in Spain have been identified. The objective of this study is to count the lifelong rehabilitation costs associated with surviving meningococcal disease with major sequelae in the Spanish setting. The results are presented in a format suitable for input into further health economic evaluations including cost-effectiveness analysis. As cost-effectiveness studies play a crucial role in determining whether immunisation programmes will be implemented, it is important to identify these costs.

2. Methods

2.1. Scenarios and resources

The approach used to estimate the lifelong rehabilitation costs associated with the survival of meningococcal disease consisted of three consecutive steps. First, two scenarios describing severe cases of meningococcal disease with major sequelae were developed. One described a case of acute meningococcal septicaemia (patient A) and the other described a case of meningococcal meningitis (patient B). Second, a list of health, educational, social care and other resources used by survivors during the treatment of their acute illness and for the rest of their life was compiled. In the last step, costs attributed to the different resources and lifelong rehabilitation costs associated with the survival of both cases of meningococcal disease were calculated.

The development of the scenarios was based on a cost study on surviving meningococcal disease published recently and conducted in the UK [3]. Scenarios from this study were adapted to the Spanish setting by conducting a literature review and interviewing three paediatricians from different Spanish hospitals to ensure that the scenarios were representative of severe cases of meningococcal disease in Spain. These paediatricians were also responsible for ensuring that the two scenarios accurately described the course of rehabilitation after survival meningococcal disease.

Once the scenarios were outlined and validated by the paediatricians, long-term health, educational, social care and other resources were collected for each scenario. For this purpose telephone interviews with six survivors or parents of survivors with sequelae similar to those of patient A and three interviews with survivors or parents of survivors with sequelae similar of those of patient B were performed. Patients were recruited by the Sant Joan de Déu hospital in Barcelona, the Clinical University Hospital in Santiago de Compostela and the Spanish association for amputations (ANDADE). Each survivor or their families were sent an informed consent for their participation in the study. Patients were interviewed from different regions in Spain including Catalonia, Galicia, Madrid and Andalusia, and it was observed that differences in benefits and reimbursement in these regions affect the overall lifelong rehabilitation costs for the treatment of severe sequelae. Other health and social care professionals including paediatricians, a paediatric surgeon, a plastic surgeon, a traumatologist, an otorhinologist, a rehabilitation specialist, social workers, a psychologist and a language and speech therapist were interviewed to obtain information regarding the support that each scenario would need for the rest of their lives and to refine resource utilisation.

Resource use was categorised into three groups: medical care, educational support and social care. As medical care is funded by the Spanish NHS and educational and social care by the government, the perspectives of this study were of the Spanish NHS and the national government. Tables 1 and 2 summarise the resources used by patient A and B, respectively.

Table 1
Patient A's resource use.

Acute care
Emergency department visit, diagnostic procedures, hospital admission during 121 days, treatment of complications such amputation surgery, renal failure, pulmonary oedema
Outpatient appointments
Regular follow-up appointments with paediatrician and traumatologist
Appointments with rehabilitation specialist and physiotherapist
Appointments with the occupational therapist to learn how to deal with the prosthetics
Five appointments with plastic surgeon to deal with the breakdown of skin graft
Specialised equipment
Children and adult wheelchair and crutches
Prosthetic provision
Non articulating low limb prosthesis, the knee is changed every three years, all other components are changed annually until the age of 16 and thereafter every two years
Upper limb cosmetic below elbow prosthesis, changed annually until the age of 16 and thereafter every two years
A micro limb prosthesis is placed only once and used until the age of four
Micro electric upper limb prosthesis with flexion and pronosupination, replacing the first micro limb prosthesis at the age of four, all parts are changed annually until the age of 16 and thereafter every two years
Cosmetic glove, changed annually
Sockets for both upper and lower limb prosthetics are changed annually
Revisions of stumps and skin graft surgery
Five surgical procedures regarding corrections of bony overgrowth and skin replacement surgery between ages of 4 and 14
Psychological therapy
Child receives weekly therapy during 20 years, parents receive three sessions a year until the child is 21
Public health care
Chemoprophylaxis for the family
Blood sample processing to analyse the bacterium
Education
Special assistance at nursery and primary school, age 3–11
Refund of University fees, age 18–21
Transport from and to school during primary and secondary school, age 5–18
Personal social services
Disabled facility grant (home care costs)
Carer allowance for parent that gave up working
Other governmental costs
Direct costs: pensioner credit due to temporal incapacity to work during study period, 18–21 years
Indirect costs: loss of tax revenues of the survivor

Table 2
Patient B's resource use.

Acute care
Emergency department visit, diagnostic procedures, hospital admission during 126 days, treatment of complications such as craniotomy, convulsions and headache
Outpatient appointments
Regular follow-up appointments with the paediatrician, twice a year the first 3 years after the acute phase and until the age of 18 annually
6-monthly appointments with neuro paediatrician, including blood tests
6-monthly appointments with the rehabilitation specialist
Annual follow-up by the neurosurgeon for control of the shunt and by the orthopaedic surgeon to monitor necessities of corrections
Annual appointments with ophthalmologist
Specialised equipment
Wheelchairs (child and adult) with different components requiring replacement with different frequency, standing frame (1×), walkers changed every three years, splinting changed annually
Public health care
Chemoprophylaxis for the family
Blood sample processing to analyse the bacterium
Cochlear implants
Hearing assessment, assessment on possibility to perform bilateral implant surgery, implant surgery with after care, revisions, posterior adjustments, renewal of the external components at the age of 13
General health problems
Pain management with botulinum toxin twice annually during all her life, administered by a neurologist
Constipation requiring lactulose until the age of 10
Double incontinence requiring an average of 4 diapers a day
Epilepsy management
Multi therapy with anti convulsive and muscle relaxant drugs (phenobarbital, levetiracetam and depakine and diazepam)
Management of epileptic crises, occurring every three years and requiring hospital admission of 2 nights
Shunt revision surgery
Two hospital admissions for fake obstructions of the shunt at the age of 5 and 28
Two hospital admissions for real obstructions at the age of 11 and 33
Education
Survivor attends special primary and secondary schools between 5–18 years, these schools offer tailored education and provide speech and language therapy and physiotherapy
Transport from an to school is required and is organised by the special school
Personal social services
Disabled facility grand (home care costs)
Carer allowance for parent that gave up working
Financial help for transport
Day care centre for activities from the age of 18
Other governmental costs
Direct: Pensioners credit due to inability to work
Direct: Funding for an orthopaedic bed, once only at the age of 7
Indirect: Loss of tax revenues survivor and parent that gave up working

2.2. Costing

The lifelong rehabilitation costs were estimated from the onset of the disease up to an age of 70, which was based on the average life expectancy of survivors with major sequelae due to meningococcal disease, based on the expected life expectancy of these patients in the UK [3]. The resource use identified during the consultation of survivors and their families, healthcare and social care professionals was cost using different sources. Unit costs for healthcare resources were derived from national or local tariff lists [12–18] or catalogues [19–22] for the regions of Catalonia, Galicia, Andalusia and Madrid. Drug costs were obtained from the Spanish Medication database [23]. Educational and social care costs were obtained from published information and documents by the national authorities [24–26]. Costs were expressed in EUR for 2012 and were updated with the consumer price index reported by the Spanish National Statistics Institute (INE) to the year 2012 if necessary [27].

Costs were presented from a NHS and governmental perspective, and discounting has been used to give less weight to future costs compared with current costs. At current cost-effectiveness analysis in Spain are presented from an NHS perspective. For the purpose of this study a wider perspective including governmental costs were also included, based on the ongoing discussion of the use of broader perspectives in economic evaluation [28]. Though costs for patients, as part from a full societal perspective for the purpose of this study were not included. The discount factor applied to costs was 3.5% until the age of 30 and 3.0% from 30 until 70 years.

All cost estimates for medical care, educational care and social care were presented at national level in the base case analysis. As considerable differences exist between medical costs at national level and the regions of interest including Catalonia, Andalusia, Galicia and Madrid, a sensitivity analysis was performed by estimating medical costs for each individual region of interest. It needs to be stated that in case of the absence of data on local costs for certain medical care resources in one of these regions, national costs were applied.

3. Results

3.1. Patient A

Patient A was diagnosed with meningococcal septicaemia at 12 months of age; suffering from severe septic shock, acute respiratory distress syndrome and renal failure for which he was treated at the Paediatric Intensive Care Unit (PICU). His respiratory and renal problems were resolved but he developed gangrene of the limbs due to purpura fulminans, leading to amputation of both legs above knee and one arm above the elbow. He spent 31 days on the PICU after which he was transferred to a paediatric ward to recover during another 90 days. Whilst recovering in the paediatric ward the patient underwent several skin graft operations.

Once discharged from hospital, patient A needed regular appointments with a paediatrician, traumatologist, rehabilitation specialist, physiotherapist, plastic surgeon and occupational therapist until the age of 18 and lifelong visits for his prosthetic provisions. He required specialist equipment with regular change of components of the prosthetics as he grew. He also had various operations of his amputation stumps at the age of 4, 6, 9, 12 and 14 years due to bony overgrowth and skin complications such as scar contractures.

Patient A attended a general mainstream nursery, primary and secondary school and required a learning assistant during the time he attended primary school to help him with tasks he could not fulfil himself. He needed special transport to and from primary and secondary school. The survivor had weekly appointments with a psychologist over 20 years, from the age of 4 years. The parents also received psychological help but less frequently than the survivor, with a total of three sessions per year until their child turned 21 years.

Patient A was one of two children in a two-parent family. One of the parents gave up working to care for the child from the moment that he became ill. This lead to a decreased family income for which personal social services were provided including a carer allowance and a disabled facility grant for home care because of the high grade of incapacity of the survivor. After high school patient A studied for four years at University after which he started working and became independent of his parents. During his studies at University he continued receiving a disabled facility grant for home care.

3.2. Patient B

Patient B was diagnosed with meningococcal meningitis at the age of 3 years. She was hospitalised with increased intracranial pressure, reduced conscious level and seizures. The child had acute hydrocephalus for which a shunt was inserted. She spent 26 days at

the PICU and once stable another 100 days at the paediatric ward to recover. Patient B was left with severe neurological damage including epilepsy and hearing problems. For these sequelae patient B required regular appointments with a paediatrician, a neuro paediatrician, a paediatric surgeon, a rehabilitation specialist and an ophthalmologist once discharged from the hospital. In order to help her with her mobility, patient B required specialist equipment such as a wheelchair, crutches and equipment to help her with her posture. Bilateral cochlear implants were implanted within the first year after the acute period for severe deafness. At the age of 13 years replacements of the external components was required. She also required several operations over the years for maintenance of the shunt. Due to behavioural and physical problems patient B needed to attend a special school until the age of 18 and thereafter she went to a day care centre.

One of the parents gave up working to care for patient B from the period of the acute illness. This impacted highly on the family's income for which they received personal social services. The family is entitled to a disabled facility grant, a carer allowance and financial help for transport for patient B. The survivor received a pension credit due to her inability to work for the rest of her life from the age of 18 years. The survivor stayed with her family for the rest of her life and did not become independent. She continued receiving personal social services including a disabled facility grant and financial help for transport to a day care centre she will visit daily for the rest of her life.

3.3. Costs

The total discounted and undiscounted lifelong rehabilitation costs for patient A and B are shown in Table 3. Prosthetic provision was the main cost driver as part of the medical costs for patient A. The highest cost for patient B concerning medical costs were acute care costs if discounted and costs for general health problems if undiscounted. The treatment for general health problems included lifelong pain treatment, constipation from the age of 3 years until the age of 10 years and lifelong double incontinence. Pain was treated twice a year with botulinum toxin injections and was responsible for more than half of the costs for general health problems.

The mean annual undiscounted costs for different age categories for patient A and B are shown in Tables 4 and 5. For patient A three age categories were defined; 0 years, 1–16 years and 17–69 years after onset of the disease while for patient B four age groups were defined; 0 years, 1–14 years, 15–50 years and 51–67 years after onset of the disease. By defining the age categories accordingly, the annual costs over time are best reflected for both patients. Annual costs were the highest in the first year after onset of the disease, for both patient A and B. These costs were largely due to acute medical care, including hospital admission with extensive medical care, covering a period of approximately one month in PICU. Medical costs for patient A decreased in the period 17–69 years post acute-illness mainly due to less frequent changing of prosthetic provision. Changes of components in prosthetic provision were necessary more frequently in youth in order to keep up with the growth of the child than when reaching adulthood. Social care costs decreased at the age of 18, as a consequence of stopping the compensation for the loss of income for the caregiver as the patient started studying after which he started working.

Medical costs for patient B were the highest in the year of acute illness and remained stable for the rest of his life post-acute illness. A small decrease in social care costs due to a decrease in the loss of tax revenues for the government was observed when the caregiver died at age of 84, at this moment the survivor was 54 years old (age category 51–67).

3.4. Sensitivity analysis

To account for uncertainty and possible differences in medical costs between the different regions in Spain, a sensitivity analysis was carried out on all components of medical costs and thus on all costs from the NHS perspective. Instead of using national unit costs for healthcare resources, local unit costs for four regions in Spain were used, including Catalonia, Galicia, Andalusia and Madrid. These regions are chosen due to the origin of the patients and their families interviewed in this study. The overview of these sensitivity analyses are provided in Tables 6 and 7 which shows the total discounted medical costs in the regions of interest compared to the costs at national level for patient A and B, respectively. All other costs, including educational-and social care costs from a governmental perspective were not considered to change. Compared to the cost at national level, the lowest medical costs for patient A were observed for the region of Madrid. In Madrid, only 40% of all prosthetic provisions are reimbursed, leading to considerable lower medical costs. On the contrary, the region of Catalonia showed the highest medical costs when compared to medical costs at national level.

Medical costs for patient B were higher in all the regions of interest compared to the medical costs at national level. At national level, the costs of cochlear implants were significantly lower than in all the regions of interest, which showed to be the main contributor to lower medical care costs at national level. When the components of medical costs were compared, Catalonia showed to have the highest costs for special equipment, resulting almost 60% higher than at national level.

4. Discussion

Surviving meningococcal disease with long-term sequelae is associated with lifelong discounted rehabilitation costs ranging from €1180,000 to €1400,000. The first year alone was already responsible for the largest annual costs, ranging from €110,000 to €140,000. After the first year after the onset of the disease the costs for patient A showed to decrease over time. The main reasons for this decrease were due to less frequent changing of prosthetic provisions. On the contrary, annual costs remained stable for survivors of meningococcal meningitis (patient B) after the first year after onset of the disease. This study showed that that resource use and costs in severe cases of meningococcal disease tend to be higher in the early years after recovery from acute illness. These results are in line with an earlier cost study for severe cases of meningitis carried out in the UK, showing very high costs in the first year after illness and decreases in rehabilitation costs over time [3]. Discounting affects future events even further, so that they become less important to a decision maker today, and depending on the applied discount rate may affect the resulting cost-effectiveness ratio. For the outcomes of cost effectiveness analyses it is important that these higher costs in the early years post-illness are fully represented by staggering the costs accordingly.

A sensitivity analysis was carried out taking into account the differences in medical costs between the four regions of interest compared to the costs at national level. For patient A variations in total costs existed of −20.8% and +17.1% in lifelong medical discounted costs between the regions of interest and national level. These differences in costs were mainly influenced by differences in costs for acute care and outpatient care and in the case of the region of Madrid by reimbursement of prosthetic provisions, which was the main cost driver concerning medical costs for surviving meningococcal septicaemia. For patient B cost variations existed of +6.7% to +12.7% between the regions of interest and national level. The differences in costs between national level and the regions were

Table 3
Lifelong discounted and undiscounted medical, education and social care costs for patients A and B expressed in EUR 2012.

Category	Patient A (septicaemia)		Patient B (meningitis)	
	Discounted	Undiscounted	Discounted	Undiscounted
Medical costs				
Acute care costs	€139,269	€139,269	€112,840	€112,840
Outpatient care	€9102	€13,400	€18,265	€43,126
Specialised equipment	€4095	€11,139	€37,936	€90,801
Prosthetics	€418,953	€934,186	n.a.	n.a.
Stump revision and skin graft surgery	€16,258	€21,683	n.a.	n.a.
Psychological problems	€23,306	€34,934	n.a.	n.a.
Cochlear implant	n.a.	n.a.	€9217	€11,715
General health problems	n.a.	n.a.	€91,232	€245,335
Epilepsy	n.a.	n.a.	€63,984	€185,458
Shunt revision surgery	n.a.	n.a.	€8151	€14,203
Public health	€75	€75	€150	€150
Educational costs				
Educational assistance	€25,942	€33,449	n.a.	n.a.
Special school	n.a.	n.a.	€154,658	€201,977
Transport from and to school	€4298	€6013	n.a.	n.a.
Social care costs				
Personal Social Services	€442,436	€733,841	€611,996	€1240,281
Other governmental costs	€99,538	€363,037	€307,432	€1003,791
Total medical costs	€611,058	€1154,686	€341,776	€703,627
Total education costs	€30,239	€39,462	€154,658	€201,977
Total social care costs	€541,974	€1096,877	€919,428	€2244,072
Total lifelong costs	€1183,272	€2291,025	€1415,861	€3149,676

Abbreviation: n.a. = not applicable.

Table 4
Average yearly undiscounted costs for patient A (meningococcal septicaemia).

Category	Number of years post-acute illness		
	0 years	1 to 16 years	17 to 69 years
Medical costs	€168,251	€22,519	€11,814
Educational costs	€0	€2167	€90
Social care costs	€28,665	€28,665	€11,501

Table 5
Average annual undiscounted costs for patient B (meningococcal meningitis).

Category	Number of years post-acute illness			
	0 years	1 to 14 years	15 to 50 years	51 to 67 years
Medical costs	€121,896	€7533	€9010	€8935
Educational costs	€0	€14,427	€0	€0
Social care costs	€33,330	€33,391	€35,072	€28,276

mainly attributable to differences in costs of cochlear implants and specialised equipment.

As mentioned earlier, prosthetic provisions were the main cost drivers concerning medical costs for patient A surviving from meningococcal septicaemia. About 3% of people surviving meningococcal disease suffered from amputations [4,29]. Considering an annual incidence of meningococcal disease of 0.96 per 100,000 inhabitants and taking into account the Spanish population size of 46,7 million inhabitants (data from 2012) [30], it is estimated that approximately 13 people would have suffered limb amputations as a consequence of meningococcal septicaemia in the year 2012. This would result in a total lifelong cost of approximately €12,144,418 undiscounted for prosthetic provisions for a group of 13 patients. This estimation shows the high economic impact for the Spanish NHS associated with the treatment of one of the sequelae of a severe case of meningococcal septicaemia.

Table 6
Sensitivity analysis on medical costs for patient A; expressed in EUR 2012.

Category	National	Catalonia	Galicia	Andalusia	Madrid
Acute care	€139,269	€151,039	€137,174	€142,965	€145,731
Outpatient care	€9102	€9102	€12,372	€8866	€29,325
Specialised equipment	€4095	€4937	€4367	€3464	€4095
Prosthetics	€418,953	€511,658	€413,668	€330,705	€252,315
Revision of stumps and skin graft surgery	€16,258	€15,555	€16,235	€17,484	€16,003
Psychological problems	€23,306	€23,306	€23,258	€44,199	€36,227
Public health	€75	€75	€75	€75	€75
Total medical care costs	€611,058	€715,673	€607,150	€547,757	€483,772
Cost difference (%)	n.a.	€104,615 (+17.1%)	−€3908 (−0.6%)	−€63,301 (−10.4%)	−€127,286 (−20.8%)

Abbreviation: n.a. = not applicable.

Table 7
Sensitivity analysis on medical care costs for patient B; expressed in EUR 2012.

Category	National	Catalonia	Galicia	Andalusia	Madrid
Acute care	€112,840	€109,647	€111,544	€83,573	€112,798
Outpatient appointments	€18,265	€18,198	€17,156	€17,753	€25,752
Special equipment	€37,936	€60,525	€33,845	€50,306	€37,936
Public health care	€150	€150	€150	€150	€150
Cochlear implant	€9217	€33,793	€40,264	€45,454	€40,230
General health problems	€91,232	€91,232	€90,730	€91,104	€93,079
Epilepsy	€63,984	€62,662	€62,191	€66,306	€65,422
Shunt revision surgery	€8151	€7724	€8737	€10,084	€9744
Total medical care costs	€341,776	€383,932	€364,617	€364,730	€385,111
Cost difference (%)	n.a.	€42,156 (+12.3%)	€22,841 (+6.7%)	€22,954 (+6.7%)	€43,335 (+12.7%)

Abbreviation: n.a. = not applicable.

This study estimated the lifelong costs for two survivors of meningococcal disease with major sequelae from a NHS and governmental perspective in Spain, which gives a broader picture of the cost to society as a whole, taking into account educational and social care besides medical costs. A strength of this study is that apart from costs at a national level in Spain, a sensitivity analysis was conducted which accounted for important differences between national level and the regions including Catalonia, Galicia, Andalusia and Madrid. Differences in medical costs as well as reimbursement between the regions resulted in important differences in lifelong medical costs between regions. By showing the results for the different regions, these costs represent the real differences that the survivors and parents of survivors that were interviewed for input on different medical resources in this study experience and reflect the day to day situation of these patients.

This study does not pretend to have a full societal perspective because costs for individual families are difficult to quantify. It is known that the day-to-day costs to bring up a disabled child is more than three times higher than to bring up other children [31] though this study intents to estimate lifelong costs for rehabilitation of major sequelae due to meningococcal septicaemia in a format that is suitable for further health economic evaluations.

This study also has several limitations. In general the life expectancy of a survivor of long-term sequelae associated with meningococcal disease was estimated at 70. Any variations in the estimation of life expectancy and actual ages of death of survivors with long-term sequelae of meningococcal disease could influence the total life time costs of these patients significantly.

In our study we relied on the input of experts to estimate resource input. Although we believe that their experience of treating survivors with severe meningococcal disease reflects daily practice, it might be possible that some sequelae have not been accounted for but which might be experienced due to an underestimation of resource use with treating the sequelae identified in our scenarios or the scenarios used are not inclusive of all the different serious sequelae that are possible after meningococcal disease. Renal failure is one of the most frequent occurring forms of organ failure with septicaemia. It is known that about a quarter to one third of the survivors that suffered from acute renal failure requiring some form of dialysis in the acute phase after meningococcal septicaemia (septic shock) still show persistent kidney damage afterwards (assessed 4 to 14 years later) which has not been accounted for in this study and could have lead to higher medical costs [6,32]. Similar, pain and headache is reported to occur frequently in 21–28% of the survivors of meningococcal septicaemia which might lead to higher costs and lower perceived quality of life [5,6]. Concerning the sequelae associated with surviving meningococcal meningitis, the frequency of hospital admissions due to decompensation of epilepsy and due to obstructions of the shunt can occur more frequently. Also, no admissions due to complicated respiratory infections are included in this study though they are thought to occur in patients surviving meningococcal meningitis, leading to higher medical care costs. Based on the profiles in this study validated by the clinical experts from three different hospitals in Spain, sequelae such as kidney damage, pain and headache and respiratory infection not accounted for though the treatment of these sequelae and consequences could affect the total lifelong costs for a survivor as well as his quality of life. We do believe that a variation in costs are possible due to the underestimation of some healthcare resources such as those mentioned as we do not present the most complex cases though this study is a first attempt to account the costs for two severe cases of meningococcal disease which can serve for further health economic evaluation. Another limitation of the study is that it relies on expert opinion for which treatment and resources might be subject to treatment preferences and also bias.

5. Conclusion

This study shows that the lifelong costs associated with the survival of meningococcal disease with severe sequelae place an important burden on the NHS budget and governmental resources in Spain as well as at regional level for the four regions of interest including Catalonia, Galicia Andalusia, and Madrid. These results fill a gap in the current knowledge on the medical costs, educational costs and social care costs associated with surviving meningococcal disease with major sequelae for the Spanish situation.

Besides high costs, the sequelae associated with severe cases of meningococcal disease also impact on the quality of life of both survivors and their relatives.

The outcomes of this study are suitable as future data for health economic evaluations and provide important information for budget planning and the management of resources for decision makers at both national and regional levels.

Contributors

Lisette Kaskens is an employee of BCN Health Economics and Outcomes Research, Barcelona, Spain, a consultancy hired by Novartis, to adapt the model to count the costs for meningococcal disease by interviewing health professionals and patients to produce the patient scenarios, collecting the costs and writing the manuscript... Josep Darbà was involved as an external advisor hired by Novartis from the Universitat de Barcelona and responsible for the review of the data and the manuscript. Mareille Hark is an employee of Novartis and Claire Wright is an employee of the Meningitis Research Foundation in the UK and participated in the review of the manuscript.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.vaccine.2014.07.019.

References

[1] Gil-Prieto R, García-García L, Alvaro-Meca A, González-Escalada A, Viguera Ester P, Gil De Miguel A. The burden of hospitalizations for meningococcal infection in Spain (1997–2008). Vaccine 2011;29(34):5765–70.
[2] Cano Portero R, Garrido Estepa M. Enfermedad meningocócica en España. Análisis de la temporada 2009–2010. Bol Epidemiol Sem 2011;19:233–46.
[3] Wright C, Wordsworth R, Glennie L. Counting the cost of meningococcal disease: scenarios of severe meningitis and septicemia. Paediatr Drugs 2013;15(1):49–58.
[4] Erickson L, De Wals P. Complications and sequelae of meningococcal disease in Quebec, Canada, 1990–1994. Clin Infect Dis 1998;26(5):1159–64.
[5] National Institute for Clinical Excellence (NICE). Bacterial meningitis and meningococcal septicaemia in children Full guideline 2010. Available at http://www.nice.org.uk/nicemedia/live/13027/49437/49437.pdf (accessed July 2013).
[6] Buysse CM, Raat H, Hazelzet JA, Hulst JM, Cransberg K, Hop WC, et al. Long-term health status in childhood survivors of meningococcal septic shock. Arch Pediatr Adolesc Med 2008;162(11):1036–41.
[7] Edmond K, Clark A, Korczak VS, Sanderson C, Griffiths UK, Rudan I. Global and regional risk of disabling sequelae from bacterial meningitis: a systematic review and meta-analysis. Lancet Infect Dis 2010;10(5):317–28.
[8] Iñigo J, Sendra JM, Díaz R, Bouza C, Sarría-Santamera A. Epidemiología y costes de la sepsis grave en Madrid. Estudio de altas hospitalarias. Med Intensiva (Barc) 2006;v. 30(n. 5):0210–5691.
[9] Gil Prieto R, Álvarez Morán JL, Portugal P, San Román Montero J, Álvaro A, Rivero Cuadrado A. Ingresos hospitalarios por infecciones meningocócicas en la Comunidad de Madrid (1997–2005). Med Clin (Barc) 2010;134(12):534–9.
[10] García-Altés A. Systematic review of economic evaluation studies: are vaccination programs efficient in Spain? Vaccine 2013;31(13):1656–65.
[11] Cortés I, Pérez-Camarero S, Del Llano J, Peña LM, Hidalgo-Vega A. Systematic review of economic evaluation analyses of available vaccines in Spain from 1990 to 2012. Vaccine 2013;31(35):3473–84.
[12] Diario Oficial de la Generalitat de Catalunya (DOGC). Diario Oficial de la Generalitat de Catalunya (DOGC) Núm 6079 2012. Available at http://premsa.gencat.cat/pres_fsvp/docs/2012/03/02/10/44/00be9c98-f20c-422d-b792-7e4a194637c0.pdf (accessed July 2013).
[13] Diario Oficial de Galicia (DOG). Diario Oficial de Galicia (DOG) Núm 213 2011. Available at http://www.xunta.es/dog/Publicados/2011/20111108/AnuncioC3K1-041111-8283_es.html (accessed July 2013).
[14] Boletín Oficial de la Junta de Andalucía (BOJA). Boletín Oficial de la Junta de Andalucía (BOJA) Núm 210 2005. Available at http://www.juntadeandalucia.es/boja/boletines/2005/210/d/updf/d28.pdf (accessed July 2013).
[15] Sistema Nacional de Salud. Pesos de los GRDs del Sistema Nacional de Salud 2008. Available at http://www.msssi.gob.es/estadEstudios/estadisticas/docs/PESOS_ESPANOLES_AP_GRD_V25_2008.pdf (accessed July 2013).
[16] Comunidad de Madrid (BOCM). Boletín Oficial de la Comunidad de Madrid (BOCM) Núm 215 2009. Available at http://www.bocm.es/boletin/CM_Boletin_BOCM/2009/09/10/2009-09-10_BOCM.pdf (accessed July 2013).
[17] Boletín Oficial del Estado (BOE). Boletín Oficial del Estado (BOE) Núm 190 2012. Available at http://www.boe.es/boe/dias/2012/08/09/pdfs/BOE-A-2012-10667.pdf (accessed July 2013).
[18] Boletín Oficial del estado (BOE). Ley 40/1998, December 9, del Impuesto sobre la Renta de las Personas Físicas y otras Normas Tributarias BOE 295 de 10 diciembre 1998. Available at http://www.boe.es/boe/dias/1998/12/10/index.php (accessed July 2013).
[19] Insalud. Catálogo General de Material Ortoprotésico (CGMO). 2000. Available at: ⟨http://www.ingesa.msc.es/organizacion/ceutaMelilla/ceuta/dirTerritorial/pdf/catalogo.pdf⟩ (accessed July 2013).
[20] Catálogo General de Material Ortoprotésico de Catalunya. Diario Oficial de la Generalitat de Catalunya (DOGC) Núm 5229 2008. Available at http://www10.gencat.cat/catsalut/archivos/catalegs/cataleg_pao.pdf (accessed July 2013).
[21] Catálogo de Material Ortoprotésico Galicia. Catálogo de Material Ortoprotésico Galicia 2003; 2003. Available at http://www.sergas.es/cas/servicios/docs/PrestacionOrtoprotesica/Catalogo_2003.pdf (accessed December 2012).
[22] Catálogo General de Ortoprotésica de Andalucía. Boletín Oficial de la Junta de Andalucía (BOJA) no 45 2006. Available at http://www.juntadeandalucia.es/servicioandaluzdesalud/library/plantillas/externa.asp?pag=/contenidos/servicios/Catalogo.pdf (accessed July 2013).
[23] Consejo General de Colegios Oficiales de Farmacéuticos (CGCOF). BOT plus web 2012. Available at https://botplusweb.portalfarma.com/⟩ (accessed November 2012).
[24] Ministerio de Educación, Cultura y Deporte. Estadísticas de precios públicos universitarios. Curso 2013–2014. Available at: http://www.mecd.gob.es/educastadisticas/precios-publicos.html (accessed July 2013).
[25] Instituto de Mayores y Servicios Sociales (IMSS). Actualización de las pensiones para 2012 2012. Available at http://www.imserso.es/imserso_01/prestaciones_y_subvenciones/pnc_invalidez/actualizacion/index.htm (accessed July 2013).
[26] Encuesta de Estructura Salarial (EES). Encuesta de Estructura Salarial (EES) 2010 2012. Available at http://www.ine.es/prensa/np720.pdf (accessed July 2013).
[27] Instituto Nacional de Estadística (INE). índice de precios de cosumo. Base 2006. Available at: http://www.ine.es/jaxiT3/Tabla.htm?t=284 (accessed July 2013).
[28] Ten Jonsson B. Arguments for a societal perspective in the economic evaluation of medical innovations. Eur J Health Econ 2009;10(4):357–9.
[29] Canavese F, Krajbich JI, LaFleur BJ. Orthopaedic sequelae of childhood meningococcemia: management considerations and outcome. J Bone Joint Surg Am 2010;92(12):2196–203.
[30] Instituto Nacional de Estadística (INE), Demografía y Población. Proyecciones de población a corto plazo. 2012–2022. Available at: http://www.ine.es/jaxi/menu.do?type=pcaxis&path=%2Ft20%2Fp269%2F2012-2022&file=pcaxis&L= (accessed July 2013).
[31] Copps J, Heady L. What price an ordinary life? The financial costs and benefits of supporting disabled children and their families. New Philantropy Capital; 2007. Available at: http://webcache.googleusercontent.com/search?q=cache:yjZmSH2gy5AJ:https://www.thinknpc.org/publications/what-price-an-ordinary-life/what-price-an-ordinary-life-2/%3Fpost-parent%3D6123+&cd=1&hl=es&ct=clnk&gl=es (accessed July 2013).
[32] Slack R, Hawkins KC, Gilhooley L, Addison GM, Lewis MA, Webb NJ. Long-term outcome of meningococcal sepsis-associated acute renal failure. Pediatr Crit Care Med 2005;6(4):477–9.