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BAPEN
Putting patients at the centre of good nutritional care

The cost of malnutrition in England and potential cost savings from nutritional interventions (full report)

A report on the cost of disease-related malnutrition in England and a budget impact analysis of implementing the NICE clinical guidelines/quality standard on nutritional support in adults

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NHS
National Institute for Health Research

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The cost of malnutrition in England and potential cost savings from nutritional interventions (short version)

National Institute for Health Research Southampton Biomedical Research Centre

NHS
National Institute for Health Research

The mission of the National Institute for Health Research Southampton Biomedical Research Centre (BRC) is to make a substantial contribution to the improvement of health through improving nutritional aspects of health promotion, prevention and treatment of ill-health. To achieve this mission the objectives are to:

- Establish a world-leading quality-assured framework within which a reliable nutritional diagnosis can be made for individuals, groups and populations;
- Develop a secure evidence base for nutritional interventions that promote health, prevent ill-health and treat disease, based upon stratified characterisation of risk, diagnosis and care, and which facilitates the achievement of appropriate nutrition competencies in the health workforce;
- Promote collaborations with clinical, academic and industry partners locally, nationally and internationally to further translational research in nutrition;
- Enable the City of Southampton to become a model for integrated, cross-sectoral nutritional well-being for the promotion of health, the prevention of ill-health and the treatment of disease across the primary, secondary, tertiary and quaternary sectors, based on stratified need.

British Association for Parenteral and Enteral Nutrition

BAPEN
Putting patients at the centre of good nutritional care

The British Association for Parenteral and Enteral Nutrition (BAPEN) is a charitable association that raises awareness of malnutrition and works to advance the nutritional care of patients and those at risk from malnutrition in the wider community. Its membership is drawn from doctors, dietitians, nurses, patients, pharmacists and the health policy, industry, public health and research sectors.

- BAPEN works to achieve its mission by raising awareness of the prevalence and impact of malnutrition, raising standards in nutritional care and developing appropriate pathways to prevent malnutrition.
- BAPEN researches and publishes the evidence on malnutrition, and provides tools, guidance, educational resources and events for all health and social care professionals to support the implementation of nutritional care across all care settings and according to individual need.
- BAPEN works in partnership with its membership, its core specialist groups and external stakeholders to embed excellent nutritional care into the policy processes and practices of all health and care settings.
- The economic report resulted from collaboration between the Malnutrition Action Group, a standing committee of BAPEN and the National Institute for Health Research Southampton Biomedical Research Centre.

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Key points

A The cost of malnutrition in England in 2011–12

Malnutrition, with and without associated disease, is a common clinical, public health and economic problem, with an estimated cost of £19.6 billion in England in 2011–12.

The public health and social care expenditure associated with malnutrition in adults and children in England in 2011–12, identified using the 'Malnutrition Universal Screening Tool' ('MUST'), was estimated to be £19.6 billion, or about 15% of the total expenditure on health and social care. Most of this expenditure was due to healthcare rather than social care, and secondary rather than primary healthcare provision involving adults, predominantly older adults, rather than children. This pattern reflects the general distribution of the total expenditure on health and social care of all subjects in England.

The large contribution of institutionalised care to total costs was not only due to the high cost of institutionalisation, but also the high point prevalence of malnutrition in hospitals and care homes. However, since more than 90% of the malnutrition originates and exists outside these institutions, preventive measures should be undertaken in the community to reduce the clinical economic burden of malnutrition.

Given the large estimated annual cost of malnutrition (£19.6 billion), small fractional cost savings translate to large absolute savings (e.g. 1% cost saving corresponds to £196 million). Effective recognition and treatment of malnutrition and continuity of care within and between care settings are of key importance to achieving such goals.

B Budget (cost) impact analysis involving implementation of the NICE clinical guidelines (CG32)/quality standard (QS24)

Interventions to combat malnutrition in the small proportion of malnourished patients targeted by the NICE clinical guidelines/quality standard on nutritional support in adults save rather than cost money. The estimated net cost saving of £172.2–229.2 million is due to reduced healthcare use.

Improvements in current nutritional care associated with fuller implementation of the NICE guideline/quality standard (identification of malnutrition and use of nutritional support in adults) not only result in better quality of care but also in a net cost saving. The investment necessary to implement better nutritional care is more than counteracted by the returns (the cost savings).

When the clinical guidelines/standard was applied to 85% of subjects with high risk of malnutrition in the population of malnourished adults targeted by the NICE guidelines/quality standard there was an overall net cost saving of £63.2–76.9 million (£119.20–145.09 thousand per 100,000 of the general population) depending on the type of nutritional support and the care setting(s). When they were applied to 85% of adults with medium and high risk of malnutrition according to 'MUST' the net cost saving was estimated to be £172.2–229.2 million in England or £324.8–432.3 thousand per 100,000 of the general population. These estimates exceeded those reported by NICE (£71,800 per 100,000 general population), which ranked the cost saving as the third highest relative to those associated with the implementation of other NICE clinical guidelines.

The above net cost savings, mostly due to appropriate use of oral nutritional supplements, represent only 0.4–3.3% of the total annual healthcare cost of disease-related malnutrition in adults, which amounted to £14.4 billion. However, the costing models involved only a proportion of patients with malnutrition presenting to healthcare workers (that targeted by the NICE guideline/quality standard), and only a fraction of this proportion received improved nutritional care. In addition, the large total cost of disease-related malnutrition included the cost of disease, much of which is not reversed by nutritional support alone.

The net cost saving was found to increase when the prevalence of malnutrition was high, when hospital admission rates were high, and when the gap between current care and desirable care was large. Rapid and reliable methods for nutritional screening were also found to produce a more favourable budget impact.

To improve the robustness of the costing model, future research should aim to establish an evidence base on healthcare use and cost of other forms of nutritional support for which little data exist (e.g. dietary advice, dietary modification and food fortification), and to further extend the evidence base on the effects of prescribable oral nutritional supplements on resource use in different care settings.

Executive summary

A The cost of malnutrition in England in 2011–12

Cost of health and social care

1. The public expenditure on healthcare in England in 2011–12 was £101.6 billion, of which £90.6 billion was spent on behalf of the resident population. Most of the purchased healthcare was secondary healthcare (£68.8 billion) and the remainder primary healthcare (£21.6 billion). It was estimated that only about 11% of the expenditure involved children less than 18 years.

2. The public expenditure on social care in England was £26.1 billion (£26.5 billion with inclusion of the costs for service strategy, asylum seekers, and other adult services) with approximately equal distribution between children (36%), younger adults (<65 years; 30%) and older adults (≥ 65 years; 34%).

3. The total public expenditure on health and social care in England was estimated to be £127.5 billion, with children accounting for approximately a sixth and the remainder, approximately equally divided between younger and older adults.

Prevalence of malnutrition

4. In healthcare, the prevalence of malnutrition varied with age and care setting. On admission to hospital it was estimated to be highest in those aged ≥65 years (33.6%), intermediate in adults <65 years (25.1%) (both measured using the 'MUST' for adults) and lowest in children (15%). At a given point in time the prevalence of malnutrition in hospitalised patients was considered to be higher than the admission prevalence, mainly because those with malnutrition have a longer length of hospital stay (30%) than those without.

5. In social care the prevalence of malnutrition also varied with age and care setting. In care home residents it was estimated to be 36% in older adults and only 24% in younger adults, who accounted for a minority of the care home population. The prevalence among older adults receiving day care and domiciliary (home) care was assumed to be 18%, and in younger adults 16%. Limited information in children receiving social care suggests that malnutrition affects only a small proportion (estimated to be 3%). For looked-after children, overweight and obesity are common and underweight distinctly uncommon.

6. At a given point in time in 2011–12 it was estimated that the number of people with malnutrition in hospital was only about 0.044 million (0.041 million publicly funded and 0.003 million privately funded), in care homes 0.142 million (0.078 million local authority funded and 0.064 million privately funded), and 0.066 million in sheltered housing. Of the total population of England in 2011–12 (53 million), 2.65million (5%) were estimated to be malnourished or at risk of malnutrition at a given point in time (2.12–3.18 million if 4–6% of the general population

is malnourished or at risk of malnutrition (estimates based on an amalgamation of surveys in hospitals, care homes, sheltered housing, and national surveys of the general population). This means that at a given point in time only about 2% of the malnutrition was accounted for by hospital inpatients.

The cost of malnutrition in health and social care

7. The public expenditure on malnutrition in healthcare was estimated to be £15.2 billion, the majority of which was due to secondary care rather than primary care. Malnourished hospital inpatients were estimated to cost £7.7 billion and malnourished hospital outpatients £0.9 billion.

8. The public expenditure on malnutrition in social care was estimated to be £4.4 billion, more than 90% of which involved adults, predominantly older adults.

9. The total public expenditure on malnutrition in health and social care was estimated to be £19.6 billion, with older adults accounting for 52% of the total, younger adults for 42%, and children for 6%. Institutionalisation of malnourished people (hospital inpatients and care home residents) accounted for up to £9.3 billion.

10. A series of one-way sensitivity analyses examining healthcare costs involved changing assumptions about the prevalence and distribution of costs by age groups in hospital inpatients and outpatients, as well as other secondary care costs and primary care costs. The sensitivity analyses examining social care costs involved changing the assumptions about the prevalence of malnutrition in residential care, the costs for assessment and management of malnourished patients, and the costs of providing domiciliary and home care to those with malnutrition or at risk of malnutrition. These sensitivity analyses affected the overall expenditure on health and social care by less than 5% and generally by less than about 2%.

11. The estimated public expenditure on healthcare was £1917 per capita of population and on social care £500 (total £2417). In those with malnutrition or risk of malnutrition it was estimated to be £5763 per malnourished subject for healthcare (based on the point prevalence of malnutrition and annual expenditure on malnutrition) and £1645 for social care. The corresponding figures for non-malnourished subjects were £1715 and £440, respectively). This means that the expenditure in a hypothetical subject suffering from malnutrition during the entire year is 3.36 times greater compared to one without malnutrition during the same period. The incremental cost of malnutrition was £5239 per subject (cost of a subject with malnutrition minus the cost of a subject without malnutrition). Expressed per capita population the estimated annual cost of malnutrition is £370 and the incremental cost £263.

12. The cost of disease-related malnutrition (and malnutrition without disease) (£19.6 billion) is estimated to account for about 15% of the health and social care budget. Small percentage cost savings resulting from interventions translate to large absolute annual cost savings (e.g. a 1% reduction in the expenditure on malnutrition is £196 million per year).

13. Malnutrition exists in all care settings and all age groups. Strategies to combat its clinical and economic consequences should be joined up across care settings and age groups.

B Budget (cost) impact analysis involving implementation of the NICE clinical guidelines/quality standard

14. A cost analysis was undertaken to examine the resource impact of implementing the NICE clinical guideline (CG32)/quality standard (QS24) on nutritional support in adults, involving only a small proportion of the total malnourished population found in England at a given point in time. The model comprised oral nutritional support with oral nutritional supplements (ONS) as well as non-ONS support, enteral tube feeding (ETF) and parenteral nutrition (PN) in hospital and community settings in England in 2011–12, and involved major modifications of a

NICE costing template. It used data from the Health and Social Care Information Centre, national surveys on the prevalence of malnutrition in various care settings, and national surveys on the prevalence of home enteral and parenteral nutrition. Systematic reviews and meta-analyses involving interventions with ONS in hospital and community settings were also used. The analyses were undertaken in the light of expert opinion about clinical data, especially those relating to current practice.

15. The costing model involved three steps: calculation of the extra cost (investment) needed to change the current pathway of nutritional care to a proposed pathway incorporating the NICE guideline/quality standard; the cost saving arising from reduced healthcare use associated with the proposed pathway; and the overall net balance (budget impact) calculated as the difference between the first two steps.

16. In the base case analysis, which assumed that 90% of malnourished subjects were screened and about 85% of those at high risk of malnutrition were provided with nutritional support, either directly by a dietitian or indirectly without a dietitian, according to local policy.

17. Five models, complementary to each other, were used to evaluate the budget impact: ONS in hospital (inpatients and outpatients) and community (new general practice registrations and care home admissions); oral (ONS and non-ONS) nutritional support in hospital inpatients and outpatients; oral nutritional support in hospital and community (new general practice registrations and care home admissions); oral nutritional support in hospital and community settings (as above) plus enteral tube feeding in hospital; and oral nutritional support and enteral and parenteral nutritional support in hospital and community settings.

18. Using all five models, the base case analyses indicated a cost saving (£101.8 – £126.6 million depending on the model) that exceeded the extra cost of implementing the proposed pathway of high quality care (£19.2 – £61.2 million). The result was an overall net cost saving of £63.2 – £76.9 million (£119.20 – £145.09 thousand per 100,000 population).

19. The largest single largest extra cost due to the implementation of the proposed pathway of care was nutritional screening (all models). In the models involving all care settings the extra costs amounted to £19.7 million or about one-third of the total extra costs, even when the costs of providing extra nutritional support with ONS, ETF and PN were taken into account.

20. Depending on the model used, older adults were estimated to account for 47–51% of the costs, 50–64% of the cost saving, and 52–76% of the net cost saving.

21. When the models were modified to ensure that the proposed pathways involved an intervention in 85% of those at medium + high risk of malnutrition according to ‘MUST’, the overall net cost saving increased to £172.2–229.2 million in England (£324.8–432.3 thousand per 100,000 people in the general population).

22. A series of one-way sensitivity analyses were undertaken which involved varying the assumptions about variables affecting the costs. These included rates of hospital admissions, prevalence of malnutrition, time taken to screen (and salary scale of person undertaking the screening), and cost savings (including reduction in length of hospital stay, hospital admissions and GP and outpatient visits.

23. The models were sensitive to variations in admission rates (±20% variation in admission rate affected the net monetary balance by ±20–25%), prevalence of malnutrition (± 3% variation affected the net balance by ±11.1–13.8%) and time taken to screen a subject (variation of ±4 minutes (base case value 5 minutes) affected the net balance by 11.1–13.8%). The models were much less sensitive to variations in the assumptions about the prevalence of malnutrition in subjects newly registering with their GP and those in care homes, and the pay scales of those undertaking nutritional assessment.

24. The single most important variable affecting the net balance was the cost saving due to the effect of ONS in reducing length of hospital stay (13.9 ± 6.6% according to a random effects meta-analysis of 12 studies involving patients with malnutrition. Variation in the cost saving by ±25% of the actual value (i.e. 13.9 ± 3.475%) affected the net balance by up to ±34%. There was uncertainty about the effectiveness of oral non-ONS nutritional support (e.g. dietary modification and/or dietary advice provided by dietitians), which could potentially have a substantial effect on the net cost saving. Other sensitivity analyses involving greatly restricted populations of malnourished subjects in the community setting (only new registrations at GP surgeries and new admissions to care homes) had little impact on the final net cost saving.

25. The models could be made more robust by evidence-based information on the effects of nutritional support in routine clinical practice. One of the important areas that needs to be addressed is the effect of oral non-ONS nutritional support on clinical and economic outcomes.

26. The estimated net cost saving was found to be greater than that reported by NICE in 2012, in which nutritional support in adults was ranked third after hypertension (clinical guideline (CG) 34) and long-term contraception (CG 30) among other cost saving schemes involving implementation of NICE clinical guidelines. While there are many differences between the current economic model and that used by NICE, a key difference is that in the current model more screening and more nutritional support were undertaken.

27. All the costing models suggest that nutritional support in adults produces a net cost saving, with important clinical implications. Local economies are likely to experience larger net cost savings from implementation of the NICE clinical guidelines/standard when the prevalence of malnutrition is high, when the rate of hospital admissions is high, and when there is a large gap between current nutritional care and desirable, high quality nutritional care.

28. Since interventions in one care setting can influence the clinical and economic burden in another, separate funding streams may create problems if one setting bears the costs the other the economic benefits. An integrated system of care with a single funding stream that follows the patient may avoid such problems.

Introduction

In 2005 the UK was the first country to publish a report on the estimated cost of malnutrition[1]. Since then the budget for health and social care in the UK has progressively increased, resulting in renewed interest in the cost of malnutrition and publication of an updated economic report in 2009[2]. The second report, although shorter than the first, used new data from the Information Centre (Health and Social Care Information Centre)/Department of Health, and also from national surveys undertaken both by BAPEN and individual groups of workers. It was apparent at the time of the publication of both reports that the cost of malnutrition was underestimated because of the omission of certain costs for which reliable data were lacking. Despite this and the approximate nature of the calculations, European workers extrapolated the cost of malnutrition in the UK to Europe as a whole[3] using only population size as the basis of the extrapolation. The BAPEN economic model was also adopted by Irish workers to estimate the cost of malnutrition in the Republic of Ireland[4]. In the meantime, it became increasingly clear that there was a need for a further update of the economic report for at least five reasons.

1. The National Health Service (NHS) expenditure in both England (Figure 1) and in the UK has been rapidly increasing between 2002/3 and 2011/12. The 2006 report was mainly based on data collected in 2003, when the expenditure on health was about 50% lower than in 2011/12, and the 2009 report was based on data obtained in 2007 (and sometimes 2006), when the budget for health and social care was about 30% lower than that in 2011/12. With such large increases in funding the cost of malnutrition would also be expected to have increased substantially.

2. Since the economic recession, which began in 2008, NHS expenditure has been scrutinised, and various avenues have been explored with the view to making cost savings. Malnutrition came under the radar screen, and it was taken into account in various proposals aiming to improve the efficiency of with which it was detected and treated. Various publications and clinical standards, including the Care Quality Commission standards and the NICE quality standard, emphasised the importance of undertaking more nutritional screening to identify and treat malnourished subjects, who would otherwise go unrecognised and untreated in routine care.

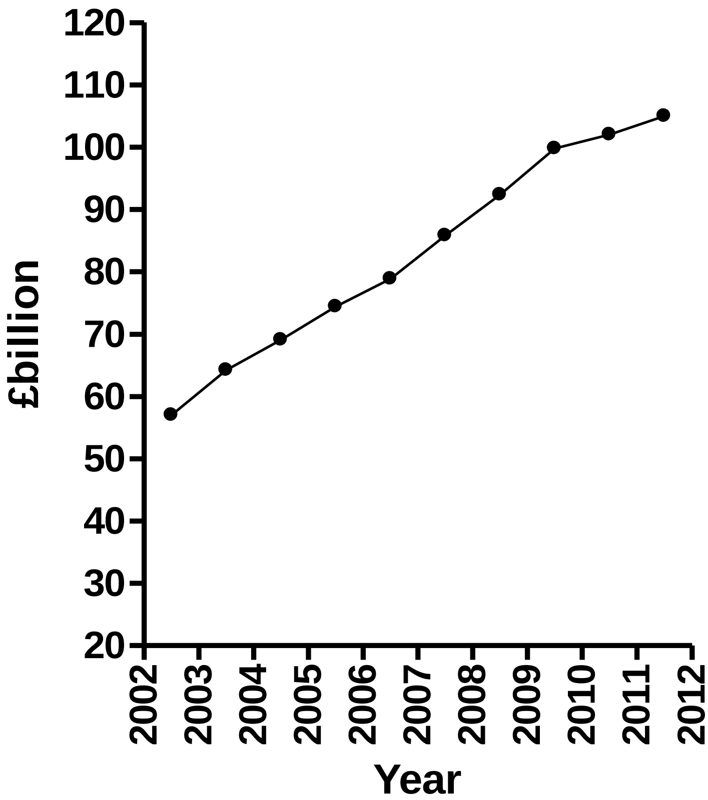


Figure 1 NHS net expenditure in England 2002/03 to 2011/12 (based on ref [5]).

3. Substantial changes in clinical practice have occurred since 2007, with more nutritional screening taking place in hospitals, and more attention being given to inspections in both hospitals and care homes. For example, the Care Quality Commission undertook both general and specific inspections on dignity and nutrition/hydration to evaluate quality of care against their standards[6, 7]. The Francis Inquiry into the failing of the mid-Staffordshire health authority[8-10] highlighted various types of problems due to poor nutrition and hydration. It concluded that there was a need to produce a culture change in order to improve clinical standards of care, with potentially important economic consequences.

4. During the recent reorganisation of the health and social services, perhaps the biggest reorganisation since the formation of the NHS almost 70 years ago, there have been changes in the way some national data have been recorded, analysed and expressed[11]. Such changes have implications about the way in which the cost of malnutrition is considered. Furthermore, as the four devolved nations of the UK (England, Scotland, Wales, and Northern Ireland) have been developing their own distinct healthcare systems using specific budgets allocated to their countries, it has become increasingly difficult to use a common framework to establish

the cost of malnutrition in the UK as a whole. Indeed, an assessment of the cost of malnutrition in an individual country is easier, and probably more practical and more useful than a single estimate for the UK as a whole.

5. Towards the end of 2012 an economic report[12] accompanying the NICE quality standard on nutritional support in adults[13] not only rekindled interest in the cost of malnutrition, but also in the potential cost saving associated with the implementation of the NICE guidelines/quality standard. The costing template that was used to establish the economic data was adopted from an earlier economic report, published in 2006 to complement the NICE clinical guidelines on nutritional support in adults[14]. One of the main findings of these reports was that appropriate nutritional support in adults produced a cost saving that was ranked third in a league table of cost saving schemes associated with the implementation of a variety of NICE clinical guidelines for a wide range of conditions. However, certain relevant issues about the costing template were raised, including the limited use of evidence-based information, the inclusion of children in some of the calculations, and uncertainties about some of the assumptions, such as the proportion of malnourished adults that should receive nutritional support.

The purpose of the present report is two-fold. First, it aims to estimate the cost of malnutrition in England and its distribution according to type of care (health and social care), age, care setting, and institutionalisation. The previous two reports were for the UK and they only partially described the distribution of costs. Second, in the light of the limitations of the earlier analyses carried out by NICE, the present report aims to undertake a new budget impact analysis to examine the effect of a nutritional intervention programme that incorporates the NICE guidelines/quality standard[13, 15]. The new information could help inform policies on nutritional support and incentivise high quality nutritional care. Part A of this report deals with the cost of malnutrition in essentially all adults and children and in Part B the budget impact analysis is restricted to those adults who are targeted by the NICE guidelines/quality standard apply and who represent only a minority of malnourished subjects found in England at a given point in time. Most contacts between healthcare workers and malnourished subjects in hospital outpatient clinics, in primary care and in care homes are not included in the model.

Part A

The cost of malnutrition in England in 2011–12

Introduction

In estimating the public expenditure on malnutrition in England in both children and adults, two datasets were considered in tandem: the public expenditure on health and social care of the general population, and the epidemiology of malnutrition. Since the funding of health and social care is often divided according to care setting, age category (e.g. children and adults) and type of service provision, an attempt was made in this report to divide the cost of malnutrition into the same categories. Part A of the report comprises three sections: the total public expenditure on health and social care of the general population; the epidemiology of malnutrition; and the estimated cost of malnutrition and its distribution. All sections involve both health and social care and although in practice these overlap, they are considered separately because they have distinct funding streams[16] and operational infrastructures.

Public expenditure on health and social care

1. Cost of health and social care

The cost of healthcare

Total costs (subjects of all ages considered together)

The total cost of healthcare in England during 2011–12 was estimated to be £101.6 billion[16]. This cost can be subdivided in various ways, including the following: costs in one geographic area versus another; administrative versus non-administrative costs; operational costs associated with the purchase of healthcare on behalf of the resident population (£90.608 billion) versus other costs; and the cost linked to the Department of Health's core bodies versus 'arm-length bodies' (£4.954 billion). The 'arm-length' bodies can be subdivided into special health authorities, such as NICE, NHS Litigation Authority, and National Patient Safety Agency (the key functions of which were transferred to the NHS Commissioning Board Special Health Authority in 2012), and Executive non-departmental public bodies, such as the Health Protection Agency, Care Quality Commission, and Monitor[16]. This report focuses on the operational expenditure, i.e. the healthcare purchased on behalf of the resident population (£90.608 billion), which accounted for 89% of the total expenditure in 2011–12. Table A.1 shows that the budget for purchasing secondary care (£68.759 billion) was about three times greater than that for primary care (£21.6 billion). The largest expenditure in secondary care involved general and acute services (£40.2 billion), while that in primary care involved general practice (GP) services and prescriptions, which together accounted for £16.0 billion, or about three-quarters of the primary care budget.

It is possible to partition the operational expenditure in even more ways, for example according to 'reference costs' and 'Payment by Results' (see Glossary). Reference costs, represent one of the major components of Payment by Results, covering most of the NHS funded acute healthcare. Unlike Hospital Episode Statistics (HES), which are based on individual diagnoses or procedures, reference costs are based on groups of diagnoses, making them simpler and operationally more practical in national payment systems. Reference costs involve a coding system which is based on grouping together similar conditions or procedures associated with similar resources (Health Resource Groupings; HRG). In 2011–12 the expenditure associated with reference costs (£53.4 billion) accounted for 59% of the total purchased healthcare, the distribution of which is summarised in Table A.2. The funding for hospital inpatients was three-fold greater than that for hospital outpatients. The funding for accident and emergency services, day admissions, regular day admissions and regular night admissions was considerably less than that for hospital inpatients and outpatients. Virtually all of the reference costs were allocated to services operating within the NHS (£53.2 billion), the remaining small proportion (<1%) being contracted out. Most of the reference costs involved 'general and acute services' operating within the secondary care sector (£40.2 billion, equivalent to 75% of the total expenditure of services with allocated reference costs). The remaining 25% included ambulance services, renal dialysis services, radiotherapy services, and diagnostic and pathology services accessed directly by GPs and independently of hospital admissions and outpatient attendances.

Community nursing services, as well as other types of community services such as midwifery, podiatry and speech therapy (which may have hospital roots or links), also contribute to the reference costs. Primary care trusts (PCTs) were not required to submit reference costs in 2011–12[16], due to the reorganisation of the NHS.

Table A.1 Operational expenditure related to purchase of primary and secondary healthcare in 2011/12

	£billion	% within section
Purchase of secondary healthcare[16]		
Learning difficulties	2.710	3.94
Mental illness	8.608	12.52
Maternity	2.621	3.81
General and acute	40.204	58.47
Accident and emergency	2.326	3.38
Community and health services	9.119	13.26
Other contractual	3.170	4.61
Total secondary care purchased	**68.759†**	**99.99†**
Purchase of primary healthcare		
GP services	7.761	35.87
Prescribing costs	8.249	38.13
Dental services	2.859	13.21
General ophthalmic services	0.491	2.27
Pharmaceutical services	2.136	9.87
Other	0.141	0.65
Total primary healthcare purchased	**21.636**	**100.00**
Capital and revenue grants	**0.212**	
TOTAL healthcare purchased	**90.608**	

†The results do not add up to the total due to rounding

It should be possible to subdivide the reference costs shown in Table A.2 even further according to type of service, type of care and care setting (Table A.1), but this would require more in-depth information from the Health and Social Care Information Centre.

Within primary care, GP services (£7.8 billion) and prescriptions (£8.2 billion) in combination accounted for 74% of the total budget (£21.6 billion).

For hospital inpatients the majority of the costs involved older adults, but for outpatients and day cases they predominantly involved younger adults. Overall, 90% of the expenditure was accounted for by adults, which was approximately equally split between younger and older adults. The remaining 10% of the expenditure involving children was small compared to the contribution of children to the general population (21% according to the 2011 census). The costs reported by PbR are not calculated in exactly the same way as those in hospital episode statistics, which helps explain the small discrepancies between results shown in Table A.3 and Table A.2, respectively.

Table A.2 Operating expenditure related to reference costs for 2011/12*

	£billion
Purchase of healthcare linked to reference costs	
Elective inpatient	5.3
Non-elective inpatient	13.7
Day case	3.6
Outpatient attendance	7.4
Outpatient procedure	0.9
Accident and emergency	2.0
Other non-acute	20.6
Total purchase of healthcare linked to reference costs	**53.4**
Purchase of healthcare not linked to reference costs	**47.2**
TOTAL healthcare purchased	**90.6**

*Calculations are based on hospital episode statistics (HES)

Table A.3 Expenditure on hospital inpatients, outpatients and day cases according to age groups in England 2011/12†

	Inpatients		**Outpatients**		**Day cases**		**All**	
	Cost (£bn)	%	Cost (£bn)	%	Cost (£bn)	%	Cost (£bn)	%
Children (0–17years)	1.744	8.9	0.765	12.5	0.379	8.5	2.888	9.6
Younger adults (18–64 years)	8.370	42.5	3.222	52.6	2.460	55.5	14.052	46.5
Older adults (≥65 years)	9.580	48.6	2.137	34.9	1.579	36.0	13.296	43.4
TOTAL	**19.694**	**100.0**	**6.124**	**100.0**	**4.418**	**100.0**	**30.236**	**100.1***

†Based on data provided to M. Elia by the Information Centre using Payment by Results (PbR)
*Does not add up to 1.000 due to rounding

The overall distribution of costs by age category based on information obtained from PbR (Table A.3) can be used to estimate the approximate distribution of ‘General and acute’ costs (Table A.1), although it is recognised that a general estimate does not necessarily apply to specific services. For example, according to 2011–12 HRG coding, £2.553 billion was expended on critical care services, of which about one-third involved neonates and paediatrics, and the remaining two-thirds involved adults, probably largely older adults. In contrast, for other less acute services, such as hospital outpatient services (see Table A.3), a greater proportion of both activity and costs was associated with the care of younger than older adults.

After excluding general and acute services, the cost of all the remaining services, including contractual services (Table A.1), accounted for £28.555 billion. The distribution of this cost by age category depends on the type of service provided. For example, the services for people with learning difficulties (£2.710 billion) were mainly distributed to children and younger adults. Maternity services (£2.621) were mainly distributed to younger women, while community and health services (£9.119 billion) were distributed to a range of adult groups, including older adults with complex problems. An approximate indication of the distribution of costs by age category for the two remaining services listed in Table A.1 (accident and emergency (A&E) and mental health services) can be obtained by considering the annual activities associated with these services. For example, for the year 2011–12 it was estimated that children accounted for about 25% of the attendances at A&E departments, younger adults (18–64 years) for about 55%, and older people (≥65 years) for the remaining 20%[17]. With respect to mental health services, calculations based on data provided by the Information Centre for the same year suggest that children accounted for only about 3% of the NHS funded services, younger adults (18–64 years) for about 63%, and older adults (≥65 years) for about 34%[18, 19]. This pattern was also reflected in the distribution of bed-days in hospital.

In the present report, a simple model of secondary healthcare expenditure was used. It assumed that 10% of the budget was allocated to children and the remaining 90% to adults, equally divided between younger and older adults (consistent with the distribution of the total cost between hospital admissions, day cases and outpatient attendances; Table A.3). In the sensitivity analyses the proportion due to younger and older adults was varied within the range 36–54% of total costs (or 40–60 % of the costs for adults alone), and in children it was varied within the range 6–14% of total costs.

An approximate estimate of the distribution of the primary care budget according to age was obtained by considering the number of GP consultations. Using data collected in 2008–09 by Q research[20] for the Department of Health it was found that 14.02% of GP consultations involved children <18 years), 54.15% younger adults and 31.38% older adults. This distribution was found to change very little from that reported in 2003–04 (14.44%, 55.06% and 30.50%, respectively) and subsequent years up to 2008–09. The data were extrapolated to 2011–12 for use in the base case analysis of this report (14% in children, 54% in younger adults, and 32% in older adults). For the sensitivity analyses, two scenarios were considered. First, with children accounting for 14% of all consultations, the proportion due to older adults was varied from 21% to 43%, implying that in younger adults co-varied from 65% to 43%, respectively. Second, with children accounting for a variable proportion of total consultations (10–18%), the remaining proportion was equally split between older and younger adults.

The cost of social care

Unlike the healthcare budget for children and adults, which is managed by the Department of Health, the social care budget for adults and children is managed separately by the Council with Adult Social Services Responsibility (CASSR) (which operating within local councils/local authorities) and by the Department of Education, respectively. In adults, the gross expenditure on personal social care in 2011–12 was estimated to be £17.23 billion (Table A.4), and in children £8.865 billion (Table A.5), making the total about £25.9 billion.

The two largest components of the expenditure in adults were residential provision for older adults (≥65 years) and day/domiciliary provision for younger adults (Table A.4). Within the former category of older adults, most of the expenditure involved individuals with dementia, and within the latter category of younger adults, most of the expenditure involved individuals with learning disability. The budget can also be divided according to the type of services provided. Of the total adult budget of £17.23 billion, 45% was due, domiciliary care provision, 44% to residential provision and the 11% to assessment and care management.

The total expenditure of social care services for children was £8.633 billion, 56% of which was associated with ‘Children looked after’ (£3.083 billion) and ‘Children’s and young people’s safety’ (£1.750 billion) (Table A.5). The remaining 44% of the budget was distributed to a wide range of services, including Sure Start children centres, family support services, and services for young people and youth justice.

The overall budget for children’s social services/care (£8.63 billion) was about the same as that for older adults (£8.92 billion) and younger adults (£7.90 billion).

Table A.4 Expenditure on personal social services for adults in England 2011/12*

	£billion			
	Assessment and care management	**Residential provision**	**Day and domiciliary provision+**	**Total**
Older people (≥65 years)	**1.02**	**4.69†**	**3.21**	**8.92**
Adults (18–64 years)				
Physically disabled	0.23	0.36	0.99	1.58
Learning disabled	0.29	2.11	2.77	5.17
Mental and health needs	0.34	0.35	0.47	1.15
Total adults (18–64 years)	**0.86**	**2.82**	**4.23**	**7.90**
Other				
Service strategy	0.05			0.05
Asylum seekers			0.02	0.02
Other adult services	0.03		0.32	0.35
Total other expenditure	**0.08**		**0.34**	**0.42**
TOTAL	**1.96**	**7.50**	**7.76**	**17.23**

*Subtotal values may not add up to the total values due to rounding
+Includes supported and other accommodation expenditure, which was grouped with residential care provision prior to 2010–11
† £4.69 billion = £1.38 billion due to nursing care placements + £3.30 billion due to residential care placements

Table A.5 Local authority expenditure on children's services and social care in England 2011/12*

Children's and young people's services	**£billion**
Youth justice	0.339
Sure Start children's centres	1.097
Children looked after	3.083
Children and young people's safety	1.750
Family support services	0.871
Other children's and families	0.402
Children's services strategy	0.216
Services for young people	0.877
TOTAL	**8.633†**

*Total values may not add up due to rounding
† With capital expenditure from revenue this becomes £8.647 billion

The cost of health and social care

Figure A.2 illustrates that the total budget for healthcare (£101.6 billion) was four-fold greater than that for social care (£25.9 billion). Of the combined budget (£127.5 billion), £118.8 billion was administered by the Department of Health (for the healthcare of adults and children, and social care of adults) and £8.6 billion by the Department of Education (for the social care of children).

Healthcare funding for children was estimated to be four-fold less than that for older adults and four-fold less than that for younger adults. In contrast, social care funding was approximately equally divided between children, younger adults and older adults (Table A.6). Sensitivity analyses suggest that these general statements are robust (see below).

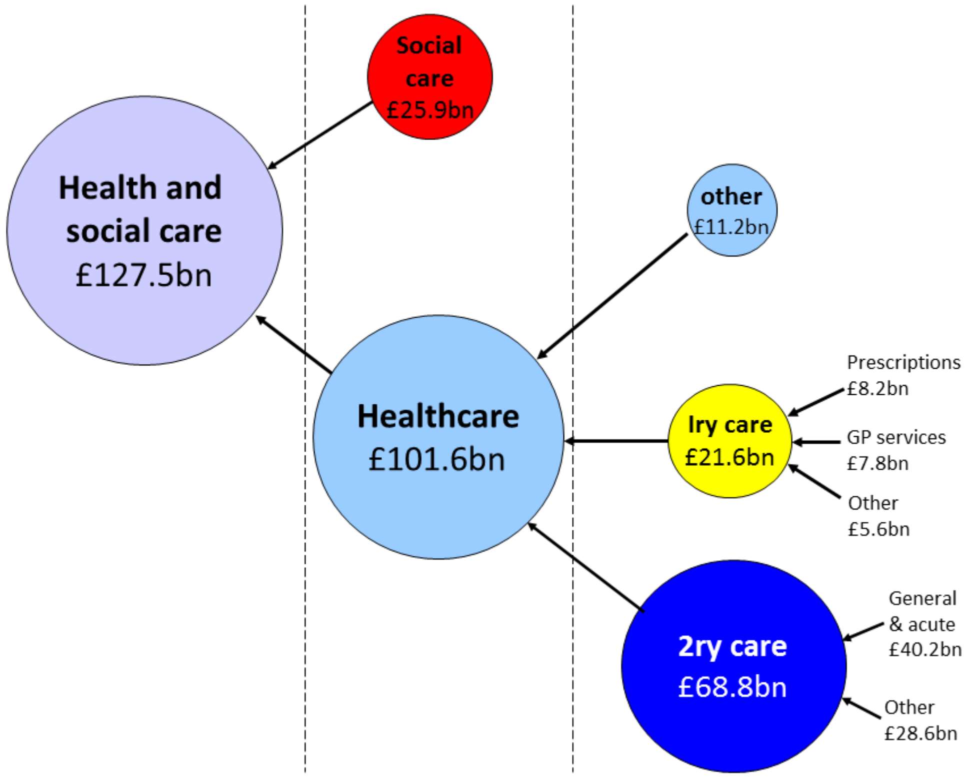


Figure A.2 Budget for health and social care in England in 2011–12. The budget for primary and secondary care relate to the purchase of care[16]. (1ry = primary care; 2ry = secondary care).

Since the age distribution of social care costs (Table A.4) and many of the healthcare costs, including the secondary healthcare costs associated with hospital inpatients and outpatients (Table A.3), are considered to be fairly robust since they were based on official figures provided by the Information Centre, the main uncertainties concern the age distribution of primary care costs and that of 'other' categories of secondary care costs, predominantly non-inpatient, non-outpatient secondary care costs. However, sensitivity analyses involving wide variations in assumptions about primary care costs altered the overall distribution by age to only a small extent. When the effects of these assumptions were expressed as a proportion of total healthcare costs (primary plus secondary care) they affected the costs within the three age categories (children (0–17 years), younger adults (18–64 years) and older adults (≥65 years) by no more than 2.7%, and of health plus social care costs by no more than 2.1%. The corresponding values for the sensitivity analyses based on assumptions involving non-inpatient/non-outpatient secondary care were 4.3% and 3.4%, respectively (Table A.7).

This information on health and social care costs will be used in combination with other data on the epidemiology of malnutrition, the focus of the next section, to calculate the overall cost of malnutrition. To maintain consistency, the epidemiology of malnutrition is considered according to the same variables as those used to subdivide health and social care costs.

Table A.6 Estimated distribution of the health and social care costs* according to age groups**

	Health care			Social care	Health + social care
	1ry	2ry	1ry+2ry		
	%	%	%	%	%
Older adults	32.0	45.1	42.0	34.1	40.2
Younger adult	54.0	45.0	47.1	30.3	43.3
Children	14.0	9.9	10.9	35.6	16.4
Children and adults	100	100	100	100	100

1ry = primary care; 2ry = secondary care
*Total primary (1ry, £21.636 billion) and secondary care (2ry, £68.759 billion) care purchased = £90.395 billion (see Table A.1); total social care = £26.13 billion (excludes £0.42 other services in adults (Table A.4)
** Children, <18 years; younger adults, 18-64 years; and older adults ≥65 years

2. The epidemiology of malnutrition

The prevalence of malnutrition was established from the Nutrition Screening Week surveys[21-25] and various other studies, which are described below. Expert opinion was also taken into account when there was little accurate information on the prevalence of malnutrition in specific conditions and specific age groups. Malnutrition was taken to be medium + high risk according to 'MUST', except where otherwise stated.

Healthcare

Secondary care

Adults

Hospital inpatients

Amalgamated data from the four Nutrition Screening Week surveys in England found that the prevalence of malnutrition (medium + high risk using 'MUST') on admission to hospital varied with age (Figure A.3) and was lowest in middle aged adults. In this document the term 'malnutrition according to 'MUST' is used to refer to medium + high risk malnutrition. The age-BMI curve was found to have a reciprocal shape to that in Figure A.3, with the highest BMI in middle-aged adults[25].

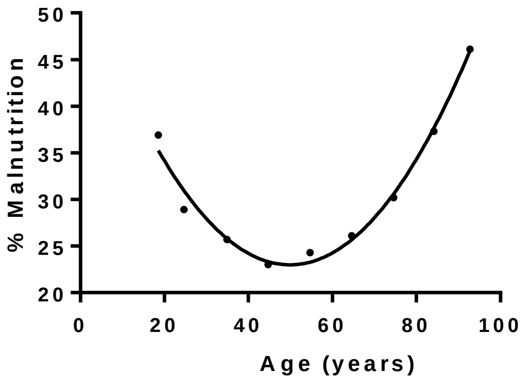


Figure A.3 The prevalence of malnutrition (medium + high risk) according to 'MUST' on admission to hospital according to 10-year age bands (based and Nutrition Screening Week survey in England, N = 23,631)[25].

Table A.7 Sensitivity analyses examining the effect of assumptions about the distribution of purchased secondary healthcare involving the 'other' category* and primary healthcare between older adults (≥65 years) and younger adults (18–64 years) and children (<18 years) on the overall distribution within health and social care sectors

Assumptions about distribution of expenditure between older and younger adults and children†	% expenditure within health and social care sectors†				
	Health care			Social care**	Health + social care
	1ry	2ry	1ry +2ry		
2ry care ('other'-£42.490 bn)+					
Scenario 1 (base case)					
Base case analysis					
Older adults (45%)	45.1	32.0	42.0	34.1	40.2
Younger adults (45%)	45.0	54.0	47.1	30.3	43.3
Children (10%)	9.9	14.0	10.9	35.6	16.4
Children and adults (100%)	100.0	100.0	100.0	100.0	100.0
Scenario 1					
Older adults (54%)	50.8	32.0	46.3	34.1	43.6
Younger adults (36%)	39.3	54.0	42.8	30.3	40.0
Children (10%)	9.9	14.0	10.9	35.6	16.4
Children and adults (100%)	100.0	100.0	100.0	100.0	100.0
Scenario 2					
Older adults (36%)	39.5	32.0	37.7	34.1	36.9
Younger adults (54%)	50.6	54.0	51.4	30.3	46.7
Children (10%)	9.9	14.0	10.9	35.6	16.4
Children and adults (100%)	100.0	100.0	100.0	100.0	100.0
Scenario 3					
Older adults (47%)	46.4	32.0	42.9	34.1	41.0
Younger adults (47%)	46.2	54.0	48.1	30.3	44.1
Children (6%)	7.4	14.0	9.0	35.6	14.9
Children and adults (100%)	100.0	100.0	100.0	100.0	100.0
Scenario 4					
Older adults (43%)	43.9	32.0	41.0	34.1	39.5
Younger adults (43%)	43.7	54.0	46.2	30.3	42.6
Children (14%)	12.4	14.0	12.8	35.6	17.9
Children and adults (100%)	100.0	100.0	100.0	100.0	100.0

Assumptions about distribution of expenditure between older and younger adults and children†	% expenditure within health and social care sectors†				
	Health care			Social care**	Health + social care
	1ry	2ry	1ry +2ry		
1ry care (£21.636 bn)++ *Scenario 1 (base case)* *Base case analysis*					
Older adults (32%)	45.1	32.0	42.0	34.1	40.2
Younger adults (54%)	45.0	54.0	47.1	30.3	43.3
Children (14%)	9.9	14.0	10.9	35.6	16.4
Children and adults (100%)	100.0	100.0	100.0	100.0	100.0
Scenario 1					
Older adults (21%)	45.1	21.0	39.4	34.1	38.2
Younger adults (65%)	45.0	65.0	49.8	30.3	45.4
Children (14%)	9.9	14.0	10.9	35.6	16.4
Children and adults (100%)	100.0	100.0	100.0	100.0	100.0
Scenario 2					
Older adults (43%)	45.1	43.0	44.6	34.1	42.3
Younger adults (43%)	45.0	43.0	44.5	30.3	41.3
Children (14%)	9.9	14.0	10.9	35.6	16.4
Children and adults (100%)	100.0	100.0	100.0	100.0	100.0
Scenario 3					
Older adults (33.5%)	45.1	33.5	42.4	34.1	40.5
Younger adults (56.5%)	45.0	56.5	47.7	30.3	43.8
Children (10%)	9.9	10.0	9.9	35.6	15.7
Children and adults (100%)	100.0	100.0	100.0	100.0	100.0
Scenario 4					
Older adults (30.5%)	45.1	30.5	41.6	34.1	40.0
Younger adults (51.5%)	45.0	51.5	46.5	30.3	42.9
Children (18%)	9.9	18.0	11.8	35.6	17.2
Children and adults (100%)	100.0	100.0	100.0	100.0	100.0

*'Other' refers to services not associated with inpatient or outpatient activity
** In these sensitivity analyses the distribution of social care costs by age group are kept constant, while those in primary or secondary care are varied
+ The expenditure refers to the component of healthcare labelled as 'other' which totals £42.9 billion and which represents all the purchased secondary care expenditure not associated with inpatient admissions and outpatient attendances
++ The expenditure refers to the entire primary care budget
† The age groups are defined as follows: older adults, ≥65 years; younger adults, 18–64 years; children <18 years

The calculations in this report were based on the following prevalence of malnutrition: adults $\geq$65 years 33.6%; adults <65 years: 25.1%.

These values were calculated by weighting the age-specific prevalence of malnutrition (see below) for the type of admission (elective and non-elective), using data from the Nutrition Screening Week surveys, and also for age-specific admission rates, using data from the Information Centre provided to M. Elia. This process was possible because both the Nutrition Screening Week surveys and the Information Centre provided data on elective and non-elective admissions according to 10-year age bands or narrower bands (10–17 years, 18–19 years, 60–64 years and 65–69 year age bands). The data from the Information Centre, based on PbR, includes most but not all of the inpatient activity, and most but not all of the HRG costs associated with inpatient activity.

A complexity is that length of hospital stay has been reported to be 1.3 times longer in 'malnourished' (medium + high risk according to 'MUST') than non-malnourished patients, in both younger and older subjects[26], with no significant difference between medium and high risk within each age category. When this is taken into account using an additional weighting procedure, the proportion of resource use due to malnutrition (to be used later to calculate the cost of malnutrition) was estimated to be as follows:

Adults $\geq$ 65 years: 39.6%; adults <65 years: 30.3%.
The additional weighting procedure involved use of the following formula:

$$\frac{\text{Healthcare use in malnourished subjects}}{\text{Healthcare use in all subjects}} = \frac{1.3p}{1 - p + 1.3p}$$

where 1.3 is the ratio of healthcare use (costs) in malnourished patients to non-malnourished patients and p is the proportion of malnourished subjects in the entire population of subjects (malnourished + non-malnourished) admitted to hospital.

In the sensitivity analysis the values were varied by ±10% of the actual values (i.e. 39.6 ± 3.96% in the older age group and 30.3 ± 3.03% in the younger age group).

Hospital outpatients
At least three studies reported the prevalence of malnutrition in hospital outpatients using 'MUST'. The first of these, which involved 321 patients attending a wide range of outpatient clinics including gastroenterology, surgery, hepatology, oncology and other types of clinics, reported the prevalence of malnutrition (medium + high risk using 'MUST') to be 15.9% (95% CI, 11.9–19.9%)[27]. The second study involving 140 patients attending a gastroenterology clinic reported the prevalence of malnutrition to be 21.3%[28], and a third study involving 205 patients attending a range of clinics, but mainly gastroenterology clinics, reported it to be 19.6%[28]. In one of these studies there was a tendency for malnutrition to be more common in older than younger patients[27], but this was not the case with the other two[28, 29]. For the purposes of this report, it was conservatively assumed that the overall prevalence of malnutrition was 15% in both younger and older adults, in the sensitivity analyses it varied within the range 10–20%.

Children

Hospital inpatients and outpatients
The prevalence of malnutrition in children admitted to hospital is difficult to establish with certainty because of the lack of standardised screening procedures. A recent study involving 247 children (1–16 years) admitted to a UK hospital reported that the prevalence of high risk of malnutrition was 10.9% according to dietetic assessment, 13.8% according to PYMS (Paediatric Yorkhill Malnutrition Score) undertaken by a nurse, and 21.1% according to STAMP (Screening Tool for Assessment of Malnutrition in Paediatrics) undertaken by a dietitian[30]. In a separate, more recent study undertaken in Manchester, the prevalence of malnutrition using STAMP was found to be 18% compared to 14% by dietetic assessment[31]. Another report, published in 2008, used an index for 'acute malnutrition' (the standard deviation score of weight-for-height of less than -2) and reported that over a 10-year period the prevalence of malnutrition in hospitalised children in various European countries and the USA varied from 65 to 14%. This probably underestimated the prevalence of malnutrition since it did

not take into account reduced weight-for-age or height-for-age, reflecting more 'chronic' forms of malnutrition. In 1990 it was reported that 14% of children admitted to a hospital in Birmingham were severely wasted and another 20% were at risk of severe malnutrition[32,33]. A prevalence of 27% undernutrition, based on weight-for-age criteria (<2 standard deviations below the reference population), was recently reported on admission to a tertiary referral paediatric hospital in London and a prevalence of 32% on discharge. In a multicentre study of 14 tertiary hospitals in 12 European countries including the UK, the prevalence of malnutrition (a low BMI defined as <2 standard deviations of a reference population) in children on admission to hospital was found to be 7%, of which 72% had moderate malnutrition and 28% severe malnutrition (<3 standard deviations for BMI). A low BMI was found to prolong length of hospital stay (by 1.3 days and 1.6 days for moderate and severe malnutrition, respectively; overall median length of stay 4 days)[34].

For the purposes of the present analysis it was assumed that malnutrition affected 15% of children admitted to a typical hospital in England and that it prolonged length of hospital stay by 1.3 times, as for adults, which means that malnutrition accounted for 18.7% of costs, when calculated using the same procedures as for adults. The sensitivity analyses involved variations of ±25% of this value (i.e. 18.7 ± 4.7%). In relation to outpatients it was assumed that 7.5% (5.0–10.0%) of attendances and costs were due to malnutrition. The prevalence of malnutrition was twice as common among children admitted to hospital than those attending outpatient clinics, which is comparable to the ratio in adults.

Primary care

Few published studies have examined the prevalence of malnutrition among patients visiting their GP in England. A survey of general practices in predominantly deprived areas reported that in adults the prevalence of malnutrition according to 'MUST' was 11.1% (6.7% moderate risk; 4.1% high risk)[35]. However, the prevalence may be lower in less deprived areas. The NICE costing document assigned a prevalence of 5% malnutrition among adults registering with their GP.

The lack of consistent criteria to identify malnutrition in children makes it difficult to establish the prevalence data in those visiting their GP, although about 2% of the reference population would be expected to be underweight according to the WHO and the 1990 UK reference growth charts.

For the purposes of the current analysis it was assumed that about 7.5% of all GP visits were associated with malnutrition in adults (lower and upper ranges ±2.5% of the mean), and that the proportion increased with age (4 (2–6)% in children, 7 (3.5–10.5%) in younger adults, and 10 (5–15)% in older adults).

Social care

Older adults (≥65 years)

Residential care provision (care home residents)

An analysis of the amalgamated results of the four Nutrition Screening Week surveys in England found that the mean prevalence of 'malnutrition' in residents admitted to care homes in the previous 6 months was 36%[21-24]. When the results were analysed at two-monthly intervals (0–1.9 months, 2.0–3.9 months, and 4.0–5.9 months since admission) there were no significant differences in three of the four surveys, but there was a significant trend for an increase when the results of the surveys were amalgamated[36]. However, intra-individual changes in weight and BMI were not affected by the duration of residency. In another cross-sectional survey in Hampshire, in which all the residents of care homes were screened (N = 1322), the prevalence of 'malnutrition' was found to be 37%[37], and not to differ significantly over the varying periods subjects had been in residential care. For the purposes of the base case analysis it was assumed that 36% (±3.6% for the sensitivity analysis) of the overall budget for residential care involved malnourished subjects.

Day and home care

Individuals receiving day and home care (see Glossary) are expected to have fewer needs and a lower prevalence of malnutrition than those in care homes, especially nursing homes, which generally cater for individuals with more severe disabilities. A study of 96 new patients referred to a district nurse team over 3 months was associated with a prevalence of 'malnutrition' (medium + high risk according to 'MUST') of 26%[38]. This may be an overestimate among those receiving day and home care, partly because new patient referrals only account for a proportion of the routine work of district nurses, partly because the nutritional status of newly referred patients may improve over time, and partly because those not referred to district nurses would be expected to have less severe disease and lower prevalence of malnutrition. It is known that the overall provision of home care varies from less than two contact hours a week to considerably more contact hours a week (e.g. more than 10 contact hours a week among those receiving intensive home care). Two studies of adults receiving home care in the Netherlands reported the prevalence of malnutrition to be 18%[39] and 21.7%[40] using different screening criteria from those used by' MUST'. Detailed information on the prevalence of malnutrition according to 'MUST' among those receiving day care at day centres, including luncheon clubs, in England is lacking. In the absence of definitive data on prevalence of 'malnutrition' in individuals receiving day and home care it was assumed that it was 18% (half of that in care homes) but a wide range (18 ± 6%, i.e. 12–24%) was used in the sensitivity analysis to reflect the uncertainty.

Assessment and management

For simplicity, it was assumed that the overall proportion of costs due to assessment and management of malnourished subjects was 29%, the same as the weighted mean value for the proportion of malnourished subjects receiving residential care (36%) and day and domiciliary care (18%) (see above). The sensitivity analyses used a fairly wide range (±25% of the actual value or 29.00 ± 7.25%) to reflect the uncertainty.

Younger adults (18–64 years)

Residential care home provision

Data from the Nutrition Screening Surveys in England indicate that the prevalence of malnutrition among younger adults admitted to care homes was 24%. This value was used to obtain an approximate estimate of the proportion of money expended on the care of younger people with malnutrition. The lower and upper limits used in the sensitivity analysis were set at 18% and 30%, respectively.

Day and home care

Since the social care expenditure on younger adults is often reported as being distributed between those with learning disabilities (65% in 2011–12) and physical and mental disabilities (~35%), the prevalence of malnutrition was examined according to these two categories. The term 'learning disabilities' is synonymous with 'learning difficulties', a term used by the Department of Education, and 'intellectual disabilities', the term used in some other countries. Learning disabilities affect 2% of the population of England (985,000, of which 828,000 are adults aged 18 years and over)[41]. Some individuals develop malnutrition because they refuse food and self-induce vomiting, or because of swallowing problems, which can result in aspiration pneumonia and the need for tube feeding. Although there is evidence to indicate that the prevalence of underweight varies with the degree of mental retardation, there is considerable variation between studies (5–43% among those published since 1989[42]). This can be largely explained by the use of different criteria to define learning disabilities in various countries and different cut-off points to define underweight. For example, use of BMI <18.5 kg/m^2 to identify underweight produces a much lower prevalence (e.g. 2.9–8.3%[43-45] in various countries) than a BMI of <20 kg/m^2 (e.g. up to 43%)[42]. Of particular relevance to the UK is a report based on a Leicestershire Learning Disability Register [45] of 1119 adults, 18.6% of whom had a BMI <20kg/m^2. The prevalence of underweight was more common in younger than older adults.

In the absence of definitive information on the prevalence of malnutrition and associated resource use in younger adults (18–64 years) with mental and physical disabilities due to a wide range of underlying causes, it was assumed that malnutrition accounted for 16% of the overall expenditure, but the sensitivity analysis used a particularly wide range (8–24%) to reflect the uncertainty. The base case value of 16% corresponds to the weighted mean value for the prevalence of malnutrition in those with learning disabilities (19%) on the one hand, and mental and physical disabilities (12%) on the other (see above).

Assessment and management

For simplicity, it was assumed that the proportion of expenditure due to assessment and management of malnourished subjects was 19%, corresponding to the weighted mean value among those receiving residential care (24%) and domiciliary and home care (16%). In the sensitivity analysis, a wide range of values was used to reflect the uncertainty (±40% of the actual value or 19.0 ± 7.6%).

Children

Although looked-after children accounted for the single largest expenditure of the children's social services (36%), information on the prevalence of malnutrition in this population is scarce. This is surprising, given that it is widely acknowledged that looked-after children are frequently abused, neglected, and have more than their fair share of behavioural and physical health problems. In one small study undertaken in Southampton, 4 out of 49 looked-after children (8%) (0.5–15 years) had growth and weight problems which resulted in a referral for monitoring[46]. In another study carried out in Surrey, 15 out of 121 children (12%) had developmental delay in physical health, but the details on nutritional status were not provided[47]. A paper published in 2008[48] stated that it was the first to review the growth of looked-after children, and it concluded from an analysis of 106 children living in London that the popular image of a slim, neglected child in care did not apply in reality. While overweight and obesity were common, underweight was distinctly uncommon. None of the children had a weight below the 2nd centile, and fewer than 5% had a weight between the 2nd and 9th centiles. For the purposes of this report, it was assumed that malnutrition accounted for only 3% of the costs of the children's social services, including those for looked-after children, but a range of 1.5–4.5% was used in the sensitivity analysis. The distribution of this expenditure between residential care, assessment and management, and domiciliary and home care was particularly uncertain, and so the one-way sensitivity analyses involved the extreme assumption that each of these three sources of healthcare utilisation accounted for 0–100% of the total expenditure on malnourished children.

Point prevalence of malnutrition in hospitals, care homes and sheltered housing

During the four quarters of 2011–12 there were on average 118,159 publicly-funded occupied night beds in hospitals[49] and 9673 occupied day beds[50] (representing an occupancy rate of 85.27% and 85.63%, respectively), making a total of 127,832 occupied hospital beds. There were also about 9500 private hospital beds (8500 occupied beds if an occupancy rate of 85% is assumed) making a grand total of 136,332 occupied beds (~6% private beds, ~7% day time beds only, and ~85% night time inpatient beds). Little information was found on the prevalence of malnutrition in patients occupying private beds and day time beds, which accounted for only about 13% of total occupied hospital beds. If it is assumed that the prevalence of malnutrition is 33%, the total number of malnourished patients in hospitalised individuals is 44,990 (136,332 × 0.33) and 42,185 patients if the publicly-funded daytime beds are excluded.

In care homes in England there were on average 224,450 local authority-supported adult residents (including adult placements of vulnerable people), according to the estimated population of supported adult residents made on 31st March 2012. Another 170,000 residents supported themselves privately[51], making a total of 394,450. This figure is about 14% lower than the estimate of 459,478 registered places made by the Care Quality Commission in 2010, which can probably largely be accounted for by non-occupancy of care home beds. The number of malnourished patients in care homes at a given point in time in 2011–12 (assuming a prevalence of malnutrition of about 35%) can be estimated to be 138,058, or three-fold greater than the number in hospitals.

In sheltered housing involving an estimated 550,000 tenants with a prevalence of malnutrition of 12% according to 'MUST' (separate studies with 'MUST' have reported a prevalence of malnutrition of 12% (10% according to dietetic opinion)[52], 12%[53] and 14%[54]), the total number of malnourished individuals can be estimated to be 66,000, which is also greater than the number of hospital inpatients.

At a given point in time he number of people with malnutrition or risk of malnutrition in hospitals, care homes and sheltered housing contributed little to the total population of malnourished subjects in England. If the point prevalence of malnutrition (medium + high risk according to 'MUST') among the 53 million people living in England in 2011–12 (general population) is 5%, this corresponds to 2.65 (2.12 million if the prevalence is 4%; 3.18 million if the prevalence is 6%). The point prevalence of 5% was estimated from a combination of data derived from national surveys in the elderly and the total population of the UK, in the light of specific surveys of hospitals care homes and sheltered housing. For example a secondary analysis[25] of the Health Surveys for England 2007–2010 showed that 3.9–4.4% of adults had a BMI <20k/gm^2 and 1.1–1.7% had a BMI <18.5 kg/m^2 (N = 28,917) (4.1% and 1.1% in 2010, respectively; N = 6792). The above data on the pre valence of malnutrition in hospitals, care homes and sheltered housing suggest that together they account for <10% of the total malnourished population, with hospitals accounting for about 2% Figure A.4 shows the data in a pie chart. In contrast to the distribution of malnutrition at a given point in time, which is dominated by the community setting, expenditure on malnutrition largely arises from the hospital setting (see next section).

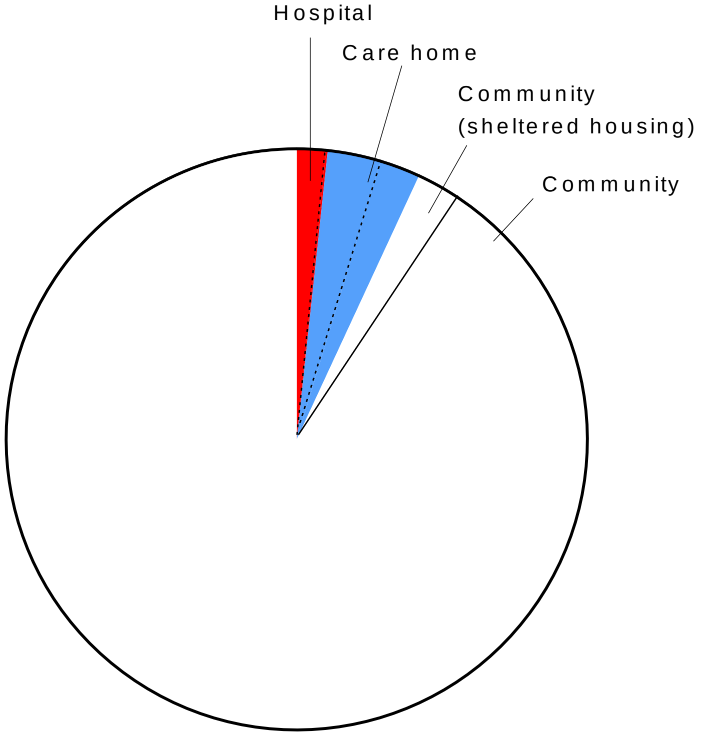


Figure A.4 The estimated distribution of malnutrition (medium + high risk using 'MUST') at a given point in time according to care setting. The dotted lines in the hospital and care home segments separate the proportions found in publicly (larger segment) and privately-funded beds (smaller segment).

3. The cost and incremental cost of malnutrition

The cost of malnutrition

Whenever possible, the cost of malnutrition was estimated from the age-specific prevalence of malnutrition and the associated resource use and, in the case of hospital inpatient admissions, the effect of malnutrition on prolonging the length of hospital stay. When there was lack of information about unit costs for specific resources according to nutritional status, it was conservatively assumed that the unit costs for malnourished subjects were the same as non-malnourished subjects.

The overall cost of malnutrition was estimated to be £19.593 billion in 2011/12 (Table A.8). This can be divided in various ways, including type of care (health and social care), age (older adults, younger adults, and children), and institutionalisation (institutional in hospital and care homes and non-institutional care) (Tables A.8 and A.9).

It can be seen from Table A.9 and also from Figure A. 5 that the overall public healthcare expenditure on malnutrition outweighed that on social care. Within the healthcare sector, the cost of malnutrition in secondary care outweighed that in primary care, and those in both in younger and older adults outweighed that in children. The cost of managing malnourished hospital inpatients was found to be greater than for outpatients, and the cost of managing malnourished subjects in institutions (hospital inpatients and care home residents) was largely due to older subjects (59.0–63.1% of the costs). Overall it was estimated that 52.3% of the expenditure on health and social care was due to older subjects and the remainder to predominantly younger adults (Table A.9; Figure A.5).

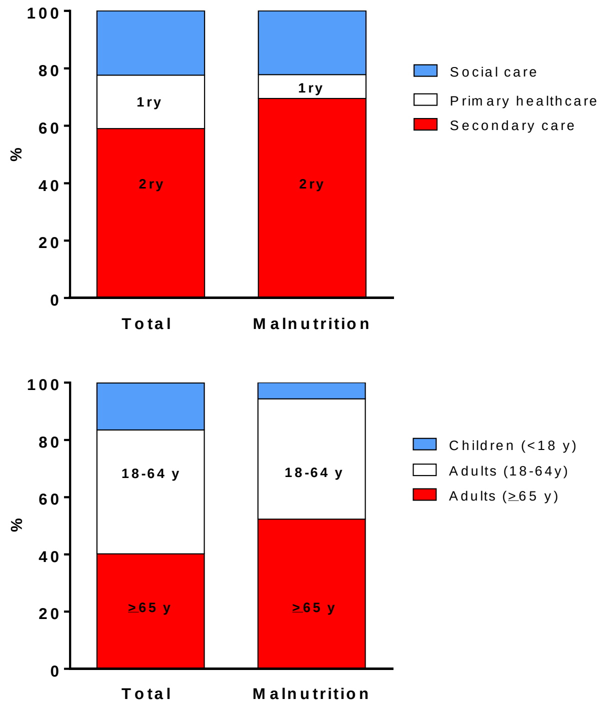


Figure A.5 The distribution of total public health and social care expenditure in England (£127.5 billion) and in the subgroup of individuals with malnutrition (£19.6 billion) according to type of care *(upper graph)* and age category *(lower graph)* (base case analysis) (1ry = primary care; 2ry = secondary care).

Figure A.5 indicates that there is a general concordance between the distribution of expenditure in the general population and that of the malnourished population, although in the latter a greater proportion is distributed towards secondary care and to older subjects (≥65 years) than in the former.

Table A.8 Total health and social care expenditure and the estimated cost of malnutrition in England 2011/12

Type of care	Expenditure (£billion)	% due to malnutrition	Cost of malnutrition (£billion)
Health care			
Operating expenditure			
Secondary care			
Hospital inpatients			
Older adults	9.580	39.6	3.798
Younger adults	8.370	30.3	2.536
Children	1.745	18.7	0.326
Adults + children	***19.694***	***33.8***	***6.659***
Hospital outpatients		0.0	
Older adults	2.137	15.0	0.321
Younger adults	3.222	15.0	0.483
Children	0.765	7.5	0.057
Adults + children	***6.124***	**14.1**	***0.861***
Other			
Older adults	19.323	15.0	2.898
Younger adults	19.323	15.0	2.898
Children	4.294	7.5	0.322
Adults + children	***42.940***	***14.3***	***6.119***
Total secondary care purchased	**68.759**	**19.8**	**13.639**
Primary care			
Older adults	6.924	10.0	0.692
Younger adults	11.683	7.0	0.818
Children	3.029	4.0	0.121
Adults + children	***21.636***	7.4	***1.631***
Total primary care purchased	**21.636**		**1.631**
Capital and revenue grants	**0.212**		
Non-operating expenditure	11.000		
TOTAL HEALTH CARE	**101.607**	**15.0**	**15.271**
Social care			
Adult older people (≥65 years)			
Residential provision: nursing and residential care	4.690	36.0	1.688
Assessment and management	1.020	29.0	0.296
Day and domiciliary provision	3.210	18.0	0.578
Total for adults ≥65 years	**8.920**		**2.562**
Adults 18–64years*			
Residential provision: nursing and residential care	2.820	24.0	0.677
Assessment and management	0.860	19.0	0.163
Day and domiciliary provision	4.230	16.0	0.677
Total for adults 18–64 years	**7.910**		**1.517**
Total adults >18 years	**16.830**		**4.079**
Children (2010–11)	**9.300**	**3.0**	**0.279**
Other*	**0.370**		
TOTAL SOCIAL CARE	**26.500**		**4.358**
TOTAL HEALTH AND SOCIAL CARE	**128.107**	**15.29**	**19.629**

Table A.9 Distribution of expenditure on disease-related malnutrition according to type of care and age group

Type of care purchased	Older adults (≥65 years)		Younger adults (18–64 years)		Children <18 years)		Total	
	£bn	%	£bn	%	£bn	%	£bn	%
Proportions between age groups								
Type of care								
Health care	7.709	50.5	6.736	44.1	0.826	5.4	15.271	100.0
Social care	2.562	58.8	1.517	34.8	0.279	6.4	4.358	100.0
Total	10.271	52.3	8.253	42.0	1.105	5.6	19.629	100.0
Healthcare								
Secondary	7.017	51.4	5.918	43.4	0.705	5.2	13.639	100.0
Primary	0.692	42.4	0.818	50.1	0.121	7.4	1.631	100.0
Total	7.709	50.5	6.736	44.1	0.826	5.4	15.271	100.0
Hospital IP & OP								
Inpatients (IP)	3.798	57.0	2.536	38.1	0.326	4.9	6.659	100.0
Outpatients (OP)	0.321	37.2	0.483	56.1	0.057	6.7	0.861	100.0
Total	4.118	54.8	3.019	40.1	0.383	5.1	7.520	100.0
Institutionalisation								
Hospital IP	3.798	57.0	2.536	38.1	0.326	4.9	6.659	100.0
Care home	1.688	*	0.677	*	<0.279	*	<2.644	100.0
Total	5.486	*	3.213	*	<0.605	*	<9.303	100.0
Proportions within age groups								
Type of care								
Health care	7.709	75.1	6.736	81.6	0.826	74.8	15.271	77.8
Social care	2.562	24.9	1.517	18.4	0.279	25.2	4.358	22.2
Total	10.271	100.0	8.253	100.0	1.105	100.0	19.629	100.0
Hospital IP & OP								
Inpatients (IP)	7.017	91.0	5.918	87.9	0.705	85.3	13.639	89.3
Outpatients (OP)	0.692	9.0	0.818	12.1	0.121	14.7	1.631	10.7
Total	7.709	100.0	6.736	100.0	0.826	100.0	15.271	100.0
Healthcare								
Secondary	3.798	92.2	2.536	84.0	0.326	85.0	6.659	88.5
Primary	0.321	7.8	0.483	16.0	0.057	15.0	0.861	11.5
Total	4.118	100.0	3.019	100.0	0.383	100.0	7.520	100.0
Institutionalisation								
Hospital IP	3.798	69.2	2.536	78.9	0.326	*	6.659	*
Care home	1.688	30.8	0.677	21.1	<0.279	*	<2.644	*
Total	5.486	100.0	3.213	100.0	<0.605	100.0	<9.303	100.0

* The percent contribution could not be computed because the total amount (£) is not precisely defined (the figure for the total is the maximum possible, due to assumptions concerning at least one of the components, which is also a maximum (see text above (last sentence) in the section on children in the 'Epidemiology of malnutrition')

A series of sensitivity analyses were undertaken to examine the extent to which assumptions about the prevalence of malnutrition in different age groups and the extent to which assumptions about the associated healthcare resources affected the results. Table A.10 shows the degree to which variations in the assumptions (input variables) within specific age groups affected the overall costs of malnutrition in healthcare, social care and health plus social care. To understand the implications of Table 10 it is first necessary to explain three issues:

1. The gaps in Table A.10 indicate that varying the assumptions about the distribution of costs within a given care sector had no direct effect on the cost of malnutrition in another sector. For example, varying the cost of malnutrition in healthcare does not directly affect the social care costs and vice versa. Furthermore, varying the assumptions about certain healthcare (or social care) costs do not directly affect other components of healthcare (or social care). For example, a change in hospital outpatient activity does not directly affect inpatient costs or primary care costs.

2. Since the relationships between input variables and costs were found to be linear, extrapolations within and outside the ranges set for the sensitivity analyses can be readily calculated. For example, if the value for an input variable (first column of Table A.10, and also Table A.8) is halved the cost will be also be halved (i.e. half the tabulated value), and if it is doubled the cost will be doubled. Although the results in Table A.10 were calculated using a series of one-way sensitivity analyses, it is possible to calculate some extreme results using two- and three-way sensitivity analyses (see Glossary). For example, the one-way sensitivity analysis for hospital inpatients was associated with variations in the cost of malnutrition of ±2.5% in older adults, ±1.7% in younger adults, and ±0.5% in children (Table A.10). If the extreme assumption is made that the lowest or highest value from each of these age categories co-vary, the combined effect on the cost of malnutrition is ±4.7% (2.5% + 1.7% + 0.5% = 4.7%; the extreme value of a three-way sensitivity analysis). If this covariance only applies to the older and younger adults, while children retain their base case value (two-way sensitivity analysis), the combined variability in the cost of malnutrition can be shown to be ± 4.2% (2.5% + 1.7% = 4.2%). Finally, Table A.10 not only shows the effects of the sensitivity analyses on the total cost of malnutrition in health and social care, but also on some of the healthcare components (i.e. those due to primary and secondary health care). It also shows the distribution of costs according institutionalisation (hospital inpatients and new residents in care homes). The absolute variations in costs due to malnutrition can be calculated by multiplying the values shown in Table A.10 (using proportions rather than percentages) by the absolute costs shown in the footnote to table A.10 (also shown in Table A.8). Factors that produce larger variations in proportional costs have a predictably larger effect on absolute costs.

   Close inspection of Table A.10 shows that when the assumptions about hospital inpatients or outpatients were individually varied within each of the three age categories there is only a small effect on the cost of malnutrition within healthcare (0.1–2.5%) and within health plus social care (0.1–1.9%). The sensitivity analyses involving older and younger adults in primary care affected the overall healthcare costs (combined primary and secondary healthcare costs) by only 2.2% and 2.6%, respectively. The biggest uncertainties about the distribution of the cost of malnutrition by age concern the ‘other’ category of secondary healthcare, which is not represented by hospital inpatient or outpatient activity. Variations in the input values for either younger or older adults for the ‘other’ category affected the healthcare costs by ±4.9%. Sensitivity analyses involving age-related variables within social care affected the social care expenditure by only ±1.5 to ± 7.8%, and the combined social and health care expenditure by considerably less (±0.3 to ±1.7%). A graphical representation of the results of the sensitivity analyses are shown in Figures A.6 and A.7. It can be seen that the overall uncertainties were dominated by adults receiving secondary care, especially the ‘other’ category of secondary care’ (non-inpatient and non-outpatient costs), which affected the overall healthcare expenditure by ±6.3%, and the overall health and social care expenditure by ±4.9%. Uncertainties about the cost of malnutrition in social care had a considerably smaller impact on the combined cost of malnutrition in health and social care.

Table A.10 Sensitivity analysis examining the effects of changing assumptions about malnutrition in older adults, younger adults and children on the total health care and social care costs of malnutrition (expressed as % of base case value) and components of these costs

	% CHANGE IN COSTS												
	HEALTH AND SOCIAL CARE			HEALTHCARE			HOSPITAL				INSTITUTIONALISATION		
VARYING THE PARAMETER (% costs due to malnutrition)	Health	Social	Total	Secondary	Primary	Total	Inpatients	Outpatients	Total		Hospital inpatients	Care home	Total
HEALTH CARE													
Secondary care													
Inpatients													
Older adults (39.6 ± 3.96%)	± 2.5	-	± 1.9	± 2.8	-	± 2.5	± 5.7	-	± 5.0		± 5.7	-	± <4.1*
Younger adults (30.3 ± 3. 03%)	± 1.7	-	± 1.3	± 1.9	-	± 1.7	± 3.8	-	± 3.4		± 3.8	-	± <2.7*
Children (18.7 ± 4.68%)	± 0.5	-	± 0.4	± 0.6	-	± 0.5	± 1.2	-	± 1.1		± 1.2	-	± <0.9*
Outpatients													
Older adults (15.0 ± 5.0%)	± 0.7	-	± 0.5	± 0.8	-	± 0.7	-	± 12.4	± 1.4		-	-	-
Younger adults (15.0 ± 5.0%)	± 1.1	-	± 0.8	± 1.2	-	± 1.1	-	± 18.7	± 2.1		-	-	-
Children (7.5 ± 2.5%)	± 0.1	-	± 0.1	± 0.1	-	± 0.1	-	± 2.2	± 0.3		-	-	-
Other													
Older adults (15.0 ± 5.0%)	± 6.3	-	± 4.9	± 7.1	-	± 6.3	-	-	-	-	-	-	-
Younger adults (15.0 ± 5.0%)	± 6.3	-	± 4.9	± 7.1	-	± 6.3	-	-	-	-	-	-	-
Children (7.5 ± 2.5%)	± 0.7	-	± 0.5	± 0.8	-	± 0.7	-	-	-	-	-	-	-
Primary care													
Older adults (10.0 ± 5.0%)	± 2.3	-	± 1.8	-	± 21.2	± 2.3	-	-	-		-	-	-
Younger adults (7.0 ± 3.5%)	± 2.7	-	± 2.1	-	± 25.1	± 2.7	-	-	-		-	-	-
Children (4.0 ± 2.0%)	± 0.4	-	± 0.3	-	± 3.7	± 0.4	-	-	-		-	-	-
SOCIAL CARE													
Residential care													
Older adults (36.0 ± 3.60%)	-	± 3.9	± 0.9	-	-	-	-	-	-		-	± 6.4	± <1.8*
Younger adults (24.0 ± 6.0%)	-	± 3.9	± 0.9	-	-	-	-	-	-		-	± 6.4	± <1.8*
Children (3.0 ± 4.50%)	-	± <3.2*	± <0.7*	-	-	-	-	-	-		-	± <5.2*	± <1.5*
Assessment and management													
Older adults (29.0 ± 7.25%)	-	± 3.9	± 0.9	-	-	-	-	-	-		-	-	-
Younger adults (19.0 ± 7.6%)	-	± 1.5	± 0.3	-	-	-	-	-	-		-	-	-
Children (3.0 ± 4.5%)	-	± <3.2*	± <0.7*	-	-	-	-	-	-		-	-	-
Domiciliary and home care													
Older adults (18.0 ± 6.0%)	-	± 4.4	± 1.0	-	-	-	-	-	-		-	-	-
Younger adults (16.0 ± 8.0%)	-	± 7.8	± 1.7	-	-	-	-	-	-		-	-	-
Children (3.0 ± 4.5%)	-	± <3.2*	± <0.7*	-	-	-	-	-	-		-	-	-

+The values in the table represent ± percentage changes from the base case analysis. The base case values and the extent to which they are varied are shown in the first column of the table. The total healthcare cost of malnutrition is as follows: health and social care cost, £19.629 billion; health care £15.271 billion (secondary care £13,639 billion, primary care £1.631 billion); hospital inpatients and outpatients £7.520 billion (inpatients £6.659 billion; outpatients £0.861 billion); institution (<£9.303 billion (hospital inpatients £6.659 billion, care home residents <£2.644 billion) (Table A.9)
* The base case value for the social care costs of malnutrition for residential care, assessment and management and day and domiciliary and home care in children was not established but in each case it was taken to be less than 3% of the social care budget (corresponding to the total social care cost of malnutrition)

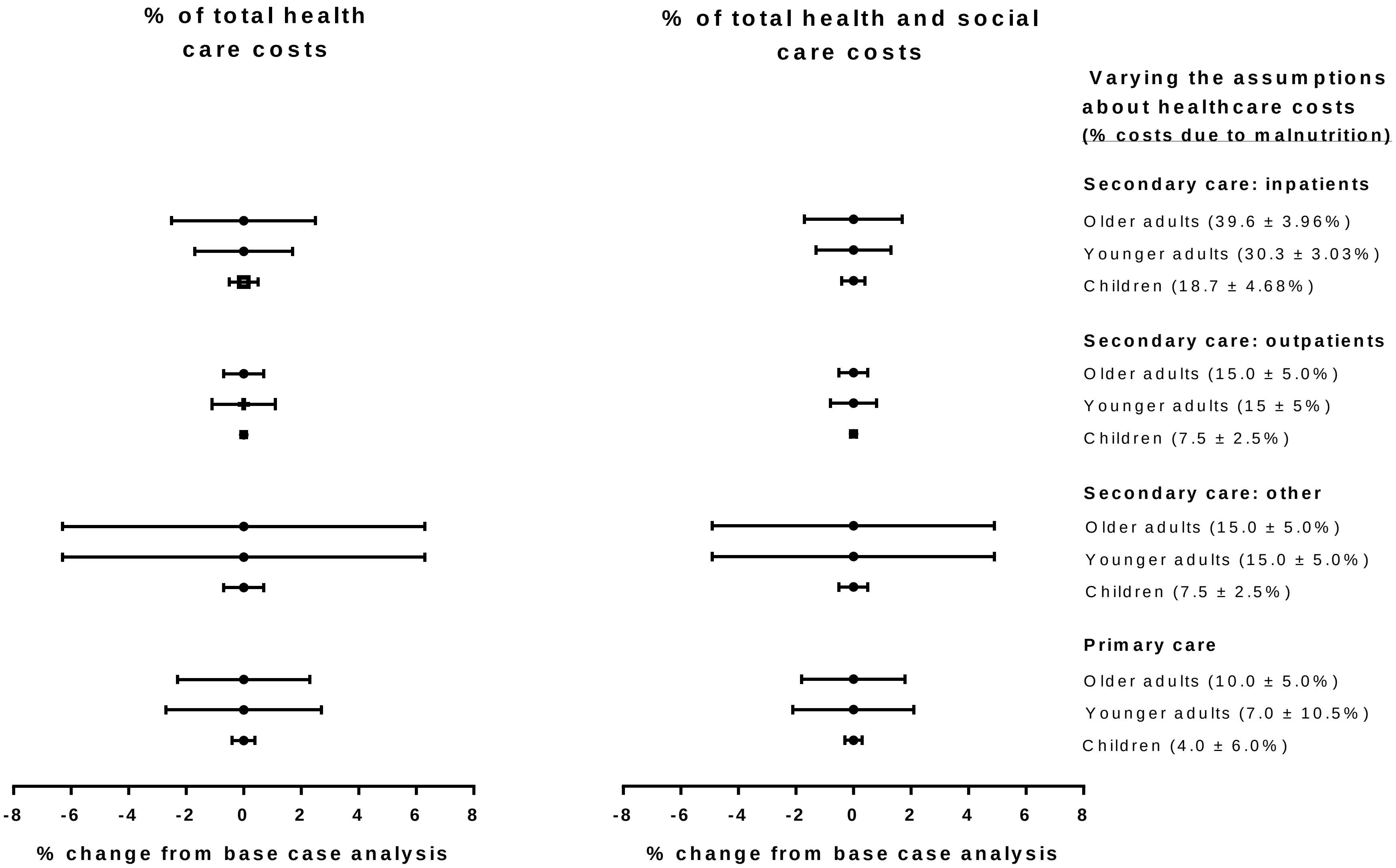


Figure A.6 One-way sensitivity analysis examining the effect of varying specific assumptions about the proportion of costs due to malnutrition in specific age groups of patients receiving specific types of primary and secondary care to the extent shown in parentheses (right of figure) on the percentage change in total healthcare costs (primary and secondary care costs, £15.239 billion in the base case analysis) and total health and social care costs (£19.629 billion) in 2011–12.

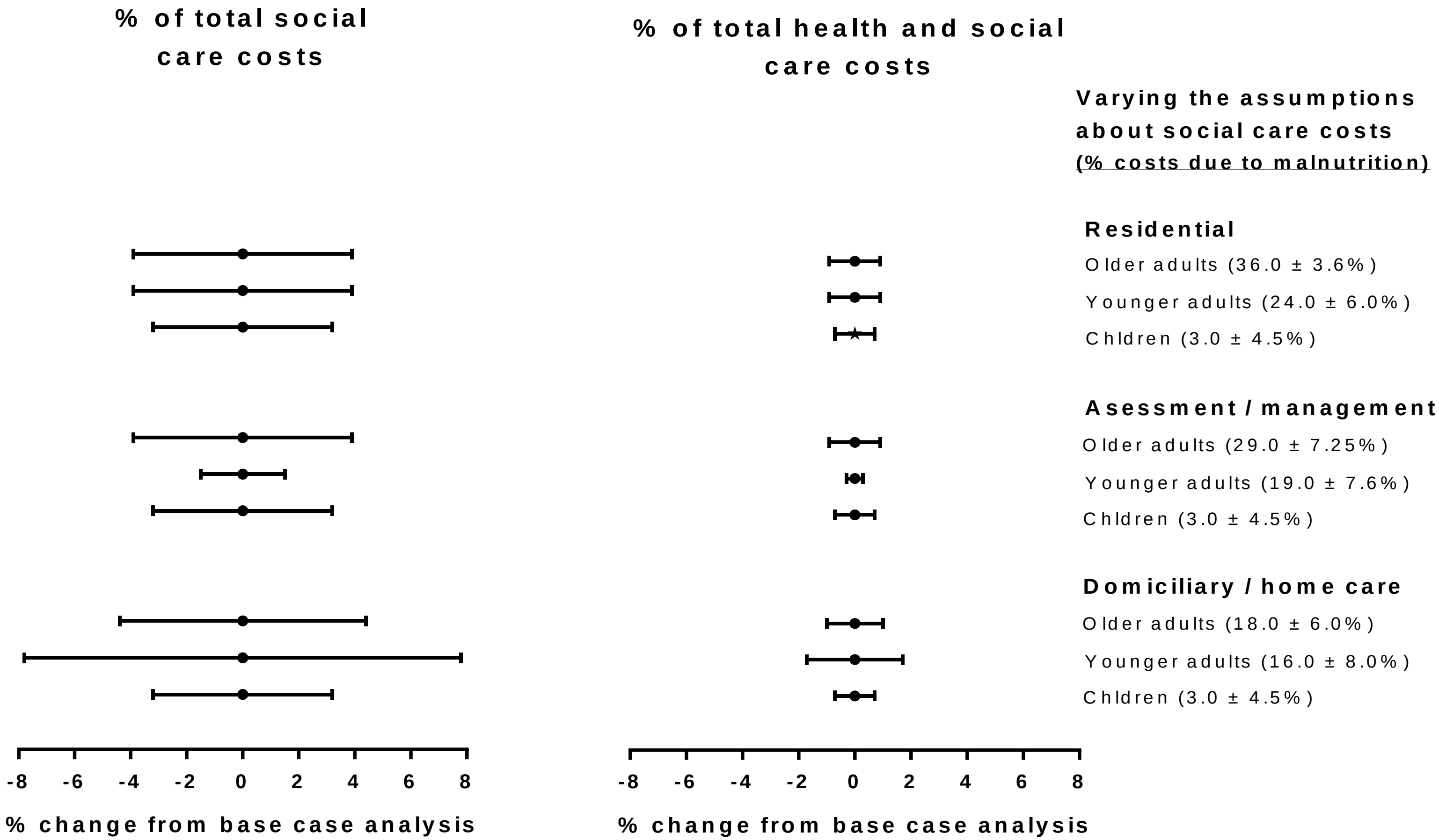


Figure A.7 One-way sensitivity analysis examining the effect of varying specific assumptions about the proportion of costs due to malnutrition in specific age groups of patients receiving specific types of social care services to the extent shown in parentheses (right of figure) on the percentage change in total social care costs (£4.328 billion in the base case analysis) and total health and social care costs (£19.593 billion) in 2011–12. The widths of those bars involving children are overestimated (see text).

The incremental cost of malnutrition

Another way of looking at the economic burden of malnutrition is to calculate the extra (incremental) cost of malnutrition. The public expenditure on health and social care (£128.107 billion) can be expressed per capita of population (£2417 given that there were 53.0 million people in England according to the 2011 census). It has been estimated from an amalgamation of data from different surveys, including those involving care homes, hospitals, sheltered housing and national community surveys in England, that about 5% or more of the general population is malnourished or at risk of malnutrition at a given point in time. Using this information and the estimated total annual health and social care cost of malnutrition (£19.629 billion) it is possible to calculate the cost per malnourished subject (£7408 per year) and non-malnourished subject (£2155 per subject per year). For the annual cost of malnutrition expressed per capita of population, this corresponds to~ £370 (~€441 using exchange rates for 2011/12) and for the incremental cost ~£263 (~€313). Figure A.8 shows that the cost per malnourished subject is 3–4 times greater than that for a non-malnourished subject, and the incremental cost 2–3 times greater than for a non-malnourished subject . Older people generally utilise more healthcare resources than younger people and it is possible that some of the increased costs associated with malnutrition occur because malnourished people are older than non-malnourished people. Analysis of data from the he Nutrition Screening Week surveys in England[25, 36] suggest that among subjects admitted to care homes those with malnutrition (medium + high risk according to 'MUST') were on average two years older than those without (P <0.001), and among those admitted to hospital those with malnutrition were four years older (P<00.1). An analysis of three individual studies of hospital outpatients[27-29] suggest that there is no significant age difference between malnourished and non-malnourished subjects, according to 'MUST', and a tendency for the malnourished to be younger by a mean of 1-3 years. Analysis of data from a study involving multiple general practices[35] suggested that those with malnutrition (medium + high risk) were 7 years older than those without, and a secondary analysis of the National Diet and Nutrition Survey of people aged 65 years and over [55] suggested that the age difference was less than 1 year. All these observation, together with additional information on age specific resource use (Information Centre for hospital related activities Q research – via the Information centre - for general practice[20]) suggest that the age discrepancy between malnourished and non-malnourished subjects accounts for only a small proportion of the incremental cost of malnutrition.

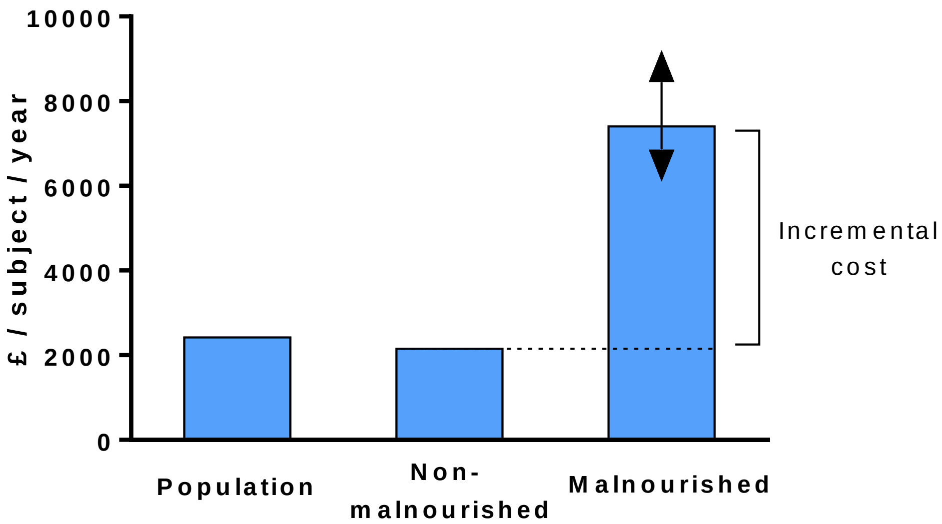


Figure A.8 Public expenditure on health and social care per subject in the general population, per subject without malnutrition and per subject with malnutrition (medium + high risk according to 'MUST'). The top of the bars represent the values calculated assuming that 5% of the population is malnourished or at risk of malnutrition. The tip of the upper arrow heads above the bar for the malnourished represents the value calculated assuming that 4% of the population is malnourished and the tip of the lower arrowhead assuming that 6% of the population is malnourished. No arrowheads are shown for the non-malnourished because the base case value was affected by only about ± 1%.

General discussion

The analysis suggests that the total expenditure on malnutrition in England in 2011–12 accounted for more than 15% of the total public health and social care expenditure. The two previous BAPEN reports suggested that malnutrition accounted for >10% of the total costs in the UK. However, the estimated cost of disease-related malnutrition appears to have increased considerably over time, (>£7.3 billion in the UK in 2003, >£13 billion in the UK in 2007 and about £19.6 billion in England in 2011–12) for at least two reasons. First, there has been a striking increase in the budget for health and social care between 2003 and 2012. Figure A.1 shows that the net NHS expenditure in England increased by about 84% between 2002–3 and 2011–12 and by about 33% between 2006–07 and 2011–12. Second, it was acknowledged at the time of publication of the earlier reports that some of the expenditure was not taken into account (e.g. the secondary care costs labelled as 'other costs', and some community and health and social care costs) and so the estimated costs due to malnutrition were minimum estimates. In contrast, the current report, involving a more complete analysis of all the major services, has estimated the cost to be about £19.6 billion.

The estimated cost of malnutrition is only approximate since there continues to be uncertainty about some of the assumptions used in the costing model (e.g. prevalence of malnutrition in certain groups of patients, see section on Epidemiology of malnutrition). However, the sensitivity analyses suggest that varying these assumptions generally has little effect on the total expenditure. Other information on the prevalence of malnutrition and on the activity associated with hospital inpatients and outpatients, which accounts for a major source of secondary care expenditure, was considered to be generally robust. The calculation procedures, which involved weighting for age, type of admission, and rates of admission, represent a refinement over those used in the previous reports. Further refinements can be made if unit costs for each type of service distinguish between malnourished and non-malnourished subjects. Unfortunately, such information is not currently available and unlikely to become available in the immediate future. In addition, modification of the of costing model is limited by the lack of accurate information on the prevalence of malnutrition in certain groups of subjects, such as those with learning difficulties, mental health problems, and those attending GP practices in various parts of the country.

The present analysis raises at least three issues of strategic importance to health and social care policies:

1. Whilst most of the malnutrition exists outside the hospital setting (estimated to be about 98% in the present and previous report[1]) most of the expenditure involves secondary care, mainly in hospitals. However, most malnutrition in hospitals originates in the community[25], which means that if it is detected and treated at an early stage in the community, it could prevent admissions or readmissions to hospital, with potentially large cost savings. The plausibility of this is suggested by a recent systematic review which reported that nutritional supplementation in the community significantly reduced hospital admissions or readmissions[56]. This topic is considered further in Part B of this report.

2. The present analysis shows that older people accounted for a considerably larger proportion of the total cost of malnutrition in health and social care (52%) compared to their head count in the general population of England (~16%). However, specific campaigns to combat malnutrition in older people should not detract from the need to also combat the problem in younger subjects, who account for about half of the costs of malnutrition. Both are important and both require attention.

3. The public expenditure on social care was found to be several times less than that for healthcare not only for the general population but also for the population of malnourished subjects. In view of the growing aging population, with an increased prevalence of malnutrition and increased long-term social care needs, the government has been considering proposals for new payment systems that take into account the financial status of the individual. Some people may decide to pay for their healthcare privately, despite having the choice of receiving healthcare from the public purse. In contrast, other people may not be eligible to receive social care from the public purse, and they may have to purchase it privately. Indeed, the proportion of social care funding from the public purse has been steadily

declining while that from the private purse has been rising. In the present analysis, only the public expenditure on health and social care was considered. According to the Organisation for Economic Cooperation and Development, private healthcare expenditure in the UK has accounted for about 17% of the total (public + private) expenditure, in agreement with a report from the Nuffield Trust[57], which indicated that in 2011 82.8% of the total UK healthcare expenditure was public health expenditure (the remaining 17.2% being private). The social care expenditure, according to an independent report on private equity companies[58], suggests that in 2011 the proportion supplied by the independent (private) sector was 33% or more for several major social care services. For example, 41% of older care home residents in Britain were considered to be 'pure' private payers in that they did not rely on public sector support and a further 14% were 'quasi' private payers in that they paid top-ups over and above the fees that local authorities were willing to pay. The combined public and private expenditure on malnutrition in health and social care is likely to be substantially higher than the public expenditure alone, perhaps by about 25%.

With the emerging differences in health and social care systems between the devolved nations of the UK (England, Scotland, Wales and Northern Ireland), it is more difficult to establish summary data for the cost of malnutrition in the UK as whole than it is for each of the nations. Nevertheless, since healthcare expenditure in the UK has been about 20% greater than in England alone (e.g. the NHS expenditure was 21% higher in 2008–09), a first approximation is that the total public health and social expenditure on malnutrition in the is UK about 1.2 times that of England (£23.5 billion). However, this may not be accurate for specific types of care, since for example public funding for social care appears to be provided more liberally in Scotland than in England. Furthermore, the cost of healthcare per capita population has traditionally been a little lower in England than in the devolved nations, and these may change further over time.

Some attempts have been made to estimate the burden of malnutrition in other countries, using different groups of subjects and methodology, including the use of different criteria for malnutrition. In the US the annual burden of community-based disease-associated malnutrition across eight disease categories was estimated to be $156.7 billion, or $508 per U.S. resident[59]. In China, the burden of disease-associated malnutrition was estimated to be responsible for 6.1 million disability-adjusted life years (DALY's) at a cost of US$66 billion annually[60]. This was considered to warrant immediate attention from public health officials and health care providers, especially since low-cost and effective interventions were also considered to be available. A few estimates have been made in some European countries[4, 61-63] using different methodology and different ways of expressing the results. In the Republic of Ireland[4], the *cost* of malnutrition was estimated to be >€1.42 billion in 2007 (>~€428 per capita of the adult population). In Germany[61] the *additional cost* of malnutrition was estimated to be €9 billion in 2006 (additional cost of ~€133 per capita of the adult population). In the Netherlands the additional cost of malnutrition in adults in 2011 was estimated to be €1.9 billion (reported to be €135 per capita adult population)[62], which was slightly greater that the overall cost of malnutrition in (€1.8 billion), as estimated by another group[63]. Unlike estimates in 2011/12 made in the present report for England (cost of €19.6 billion (£370 (€441) per capita population) and additional cost of £13.9 billion (£263 (€313) per capita population), those in other countries did not include children. The lower cost of malnutrition in one of the Dutch studies[63] was associated with exclusion of children and those living at home, and assumptions about the prevalence of malnutrition in hospitals and care homes, which were substantially lower than those in England.

This section of the report has not considered the effects of interventions. However, nutritional interventions producing only small fractional cost-savings could translate to large absolute cost savings. For example, a 1% cost saving of of £19.6 billion corresponds to £196 million. Part B of this report therefore goes on to consider the way in which improvements in the current pathway of care provision, according to the NICE guidelines/quality standard on nutrition support in adults, can help combat malnutrition and produce a favourable cost impact. The guidelines/quality standard target only a proportion of malnourished subjects, representing only a minority of people attending GP surgeries and hospital outpatient clinics, and only a minority of those in residential care. While it is clear that the budget impact analysis in Part B of this report only addresses one part of the of the malnutrition problem, it provides some important insights into the effects of nutritional interventions that are relevant to the development of clinical and public health nutrition polices and strategies.

Part B

Budget impact analysis involving implementation of the NICE clinical guidelines (CG32) and the NICE quality standard (QS24) on nutritional support

Introduction

One of the standard methods of improving the quality of clinical care is to define current clinical practice, identify its shortcomings, and then correct them by implementing high quality standards of care. To facilitate the process NICE has been tasked with producing clinical guidelines and quality standards based on the best available evidence. In February 2006 it released its clinical guidelines on nutritional support in adults[13], and in November 2012 it released the related quality standard[12]. Both documents were accompanied by costing reports which examined the financial consequences of changing the prevailing (current) pathway of nutritional care to one (the proposed pathway) that incorporated the NICE clinical guidelines/quality standard. The first costing report (2006) indicated that implementation of the proposed pathway of nutritional care produced a net cost saving of £28,000 per primary care trust (PCT), and the NICE website (http://www.nice.org.uk/usingguidance/benefitsofimplementation/costsavingguidance.jsp updated November 2011 and accessed on 25.01.12) indicated a net cost saving of £28,472 per 100,000 of the general population. The second costing report (2012) registered a higher net cost saving, amounting to £71,800 per 100,000 of the general population. This increase was due to changes in clinical practice between the publication of the first and second reports, as well as to changes in some of the assumptions of the costing model. Despite these differences, the two reports shared many common elements, one of the most important of which concerned the effect of oral nutritional supplements (ONS) in reducing the cost of hospitalisation in malnourished subjects. This cost-saving alone was more than sufficient to counteract the extra costs necessary to implement the proposed pathway. Therefore, the net cost saving associated with implementation of the quality standard on nutritional support in adults was ranked third among all other calculated cost savings associated with implementation of NICE clinical guidelines for the management of a wide range of different clinical conditions (http://www.nice.org.uk/usingguidance/benefitsofimplementation/costsavingguidance.jsp).

Despite the importance of these seminal reports, further budget impact analyses were deemed necessary for at least four reasons.

1. Although the NICE guidelines and quality standard on nutrition support were developed for adults only, certain parts of the NICE costing model incorporated data on children over 14 years, and another part data from children of all ages (see Appendix: Activity). The extent to which inclusion of children affected the budget impact analysis was not clear.

2. The evidence base underpinning the costing model was limited. Assumptions about the extent to which ONS reduced healthcare use are particularly important, because they represented the only source of potential cost saving. Only limited justification appears to have been provided for certain assumptions. For example, the proposed pathway of care assumed that different proportions of malnourished patients would receive and obtain benefit from oral nutritional support (and this only from ONS): 37.5% of hospital inpatient admissions; 1.8% of first outpatient attendances (one-tenth of those referred to a dietitian); 28% of new registrations at GP clinics; and 33.3% for new admissions to care homes. To examine the potential cost impact of the NICE clinical guidelines/standard more fully, it is reasonable to suggest that the vast majority of malnourished patients (or at least the vast majority of those at high risk of malnutrition) should consistently receive appropriate nutritional support in all care settings. A consistent and reliable approach should also be used to ensure that the number of subjects gaining benefit from nutritional support does not exceed the number receiving it[14].

3. It is difficult if not impossible to accurately establish the optimal activity for enteral tube feeding (ETF) and parenteral nutrition (PN). Indeed, any activity assigned to the proposed pathway of care, including one aspiring to meet the NICE guidelines/quality standard, can be regarded as approximate at best and misleading at worst. Gathering the necessary evidence to inform the process can be very challenging, especially since it is unethical to undertake certain types of studies, for example comparing ETF (or PN) with no ETF (or PN) in specific patient groups who clearly need such support in order to keep alive and/or avoid developing distressing symptoms. In addition, the perceived 'optimal' activity may change over time, as new evidence is gathered, as the status of local economies changes, and as clinical and social attitudes towards the distribution of limited resources change. For example, about 30 years ago it was proposed to

the Department of Health that at a given point in time only about 2 per million of the general population was likely to require home PN, and that this figure was unlikely to increase by much more in the future. However, home PN activity has increased by about 10 times since then so that it is now being given to almost 20 per million of the population in several areas of England and the UK (see Appendix: PN activity). The growth of home ETF has been even more pronounced[64], and that of ETF and PN in the hospital setting has been considerable. For example, PN has been used increasingly to support hospitalised patients receiving aggressive chemotherapy for haematological problems, bone marrow transplantation and new surgical procedures. With increasing recognition that PN can support and aid recovery from certain interventions, including surgical procedures which can produce complications such as prolonged ileus and fistulae, PN appears to have been used more widely and more liberally than in the past. In addition, attitudes towards using ETF and PN can change over time as new evidence about efficacy becomes established.

4. The NICE model assumed that the use of ETF and PN only increased costs, leaving no possibility for a potential cost-saving. This meant that increasing the activity of ETF/PN in the proposed pathway of care could only produce a more unfavourable budgetary consequence. It can be argued that use of ETF/PN in certain groups of hospitalised patients can produce at least some favourable budgetary consequences by aiding recovery from illness and reducing the length of hospital stay. It can also be argued that a cost impact analysis is of limited value when applied to treatments such as home ETF/PN, which are often used to save lives rather than save money. It may be more appropriate to assess the value of home ETF/PN using a cost-effectiveness analysis, based on societal thresholds for willingness to pay, rather than using a budget impact analysis.

This part of the report explores these complex issues, making greater use of evidence-based information than previous reports, while continuing to rely on expert opinion to clarify certain issues about current practice. The work also identifies the relative importance of various factors that influence the costing model. This approach not only helps make recommendations more convincing, but also identifies key areas of research that need to be undertaken to make the costing model more robust. The findings from this section of the report should also help incentivise and facilitate implementation of guidelines and standards on nutritional care in adults and implementation of policies to combat the burden of malnutrition. It must be noted however, that most of the malnutrition in England and most of the contacts between malnourished adults and healthcare workers in hospital outpatients, in primary care and in care home settings are not included in the model, which was initially developed to consider only the population targeted by the NICE guidelines/clinical standard on nutritional support in adults. Therefore the model does not reflect the budget impact that might result from a combination of preventive and therapeutic interventions on all malnourished subjects.

1. An overview of the costing model

The costing model involved three steps. The first step calculated the extra cost (the investment) needed to change practice from the current pathway of nutritional care to one (the proposed pathway) that incorporated the NICE guidelines/quality standard. The second step calculated the cost-saving arising from reduced health care use following implementation of the proposed pathway of nutritional care. The third step calculated the overall balance (budget impact) from the difference between the extra costs (step 1) and the cost savings (step 2) (Figure B.1).

The costs

The current pathway of care was established using data obtained from the Information Centre, national surveys[25], various studies on the prevalence of malnutrition in various groups of subjects in different care settings (see Epidemiology of malnutrition in Part A of this report), salary scales from the NHS staff Council[65] and expert opinion about current practice, including contract arrangements with concessions.

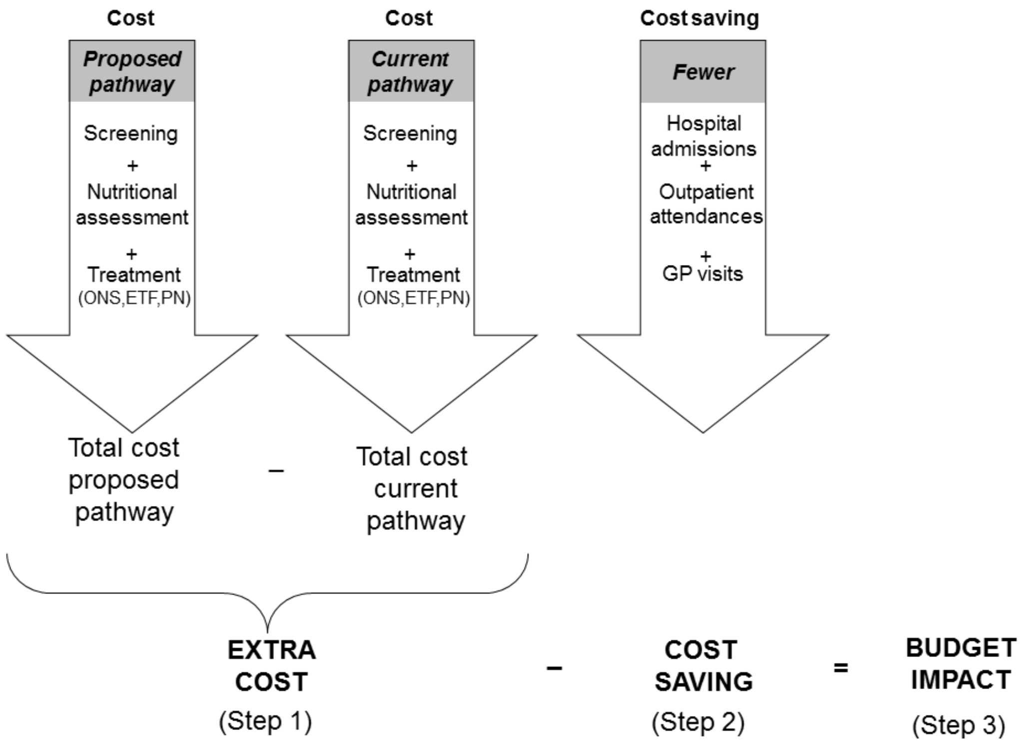


Figure B.1 Flow diagram illustrating the basic model involving both hospital and community settings.

The proposed pathway was characterised by the following key features (see Appendix for further details and assumptions):

1. *Screening:* The base case model assumed that 90% of the population entering each care setting over a period of a year was screened using 'MUST'. Although 100% compliance would be ideal, 90% was considered more realistic.

2. *Assessment:* The proposed pathway assumed that 80–90% of malnourished people were either assessed for nutritional support by a specialist (typically a dietitian recommending ONS or other oral dietary intervention, or artificial nutrition). Some patients may be given ONS without being assessed by a specialist (e.g. by following local policies for specific patient groups). The proportion referred for assessment varied with the care setting and subject group. It was higher for people admitted to hospital than those admitted to care homes or registered with their GP (see Appendix for details).

3. *Treatment: a) oral nutrition*: To ensure that 80–90% of patients at high risk of malnutrition were given oral nutrition support, the model specified 33% more activity in the proposed pathway than the current pathway in the hospital setting, and 66% more activity outside the hospital setting, enabling items 1 and 2 to be fulfilled. The effects of ONS on healthcare use were largely based on information obtained from systematic reviews with meta-analyses (see Glossary). However, due to the scarcity of evidence based information on the effect of non-ONS oral nutrition support on healthcare utilisation, the assumptions varied widely in the sensitivity analyses. The impact of treating 80–90% of patients with medium + high risk of malnutrition was also examined.
   b) ETF and PN: Given the uncertainty that exists about the optimal number of patients that should receive ETF and PN, a number of models were developed to examine different budget impact analyses, some of which included ETF and PN and others which did not. As a starting point, the activities of ETF and PN in the proposed pathway were assumed to be 16% higher than those in the current pathway in the hospital setting, and 8% in the community setting, in keeping with those

used in the NICE model (16.7% and 8% increase, respectively). In the sensitivity analyses these activities were varied from 0 to 32% in the hospital setting, and from 0 to 16% in the community setting. Since a linear relationship was found between variations in these (and other) assumptions, the final net cost saving can be readily calculated within and beyond the specified ranges of the sensitivity analyses.

Unit costs were based on data provided by the Information Centre (cost of a hospital inpatient admission (spell) and outpatient visit), Curtis[66] (GP visits and salaries), the NHS staff Council (salaries)[65], and the British National Formulary (for oral, enteral and parenteral feeds) issued in 2011–12. Expert opinion was also sought to provide supplementary information about price concessions operating in current practice.

The cost-savings

The cost-saving due to appropriate use of ONS, established through systematic reviews and meta-analyses of randomised controlled trials, were subjected to sensitivity analyses in which the input variables were varied within specified upper and lower limits, in an attempt to match the degree of uncertainty. This included the use of the 95% confidence limits obtained from a meta-analysis examining the effect of ONS on length of hospital stay. Also examined were variations in the rates of hospital admissions, prevalence of malnutrition and the proportion of subjects with malnutrition or risk of malnutrition given nutritional support.

The budget (cost) impact analysis

The budget impact analysis required information about the extra costs and cost savings associated with implementing the proposed pathway of care (i.e. the cost implications of changing from the current to the proposed pathway of care).

2. Calculating the extra cost of implementing the proposed pathway

Both the current and proposed pathways of care involved four care settings: two in hospital (inpatients and outpatients) setting and two in the community (general practice and care homes) setting. The components of the model are summarised in Table B.1 in the form of a 3 × 4 factorial matrix. The component involving treatment was subdivided into three separate types of nutritional support (ONS, ETF and PN).

The cost associated with each cell of Table B.1 was calculated using the following simple equation:

Annual cost = unit cost × annual activity (number of units per year).

For example, the annual cost of nutritional screening was calculated by multiplying the cost of a single screen by the total number of screens in a year. Similarly, the annual cost of ONS was calculated by multiplying the daily cost of using ONS in a single patient (the cost of an ONS-patient day) by the total number of ONS-patient days in a year. Since the cost of the same treatment differs between settings, separate calculations were undertaken for each setting.

Unit costs

A summary of unit costs for screening, assessment and treatment (ONS, ETF and PN) is provided in Table B.2. Within each care setting the same unit costs apply to both the current and proposed pathways (see Appendix for details).

Table B.1 Matrix of component costs associated with the current and proposed pathways

	Hospital inpatients	Hospital outpatients (new attendances)	Community (new GP registrations)	Community (care home and own home)
Screening	Screening hospital inpatients	Screening hospital outpatients	Screening GP practice	†
Assessment	Assessment hospital inpatients	Assessment hospital outpatients	Assessment GP practice	Assessment community
Treatment: ONS	ONS hospital inpatients	ONS+ hospital outpatients	ONS	ONS community
ETF	ETF hospital inpatients		*	ETF community
PN	PN hospital inpatients	*	*	PN community

ONS = oral nutrition supplements; ETF = enteral tube feeding; PN = parenteral nutrition; GP = general practitioner
† Since screening in care homes is not funded by the NHS (it is financed by the social care services), it is not considered
+ Although the patients are living in the community these ONS costs are paid by the hospital. If ONS are to be continued they are paid from the GP practice (primary care) budget
* Any ETF or PN already taking place in patients registering with their GP is included in the last column (community-home enteral tube feeding or home parenteral nutrition)

Table B.2 Unit costs for screening assessment and treatment for both the current and proposed pathways

	Hospital inpatient	Hospital outpatients	Community (new registrations with GP)	Community (care home and own home)
1.Screening	£1.67	£1.29	£1.84	-
2.Assessment+	£16.45	£16.45	£16.45	£16.45
3.Treatment*: ONS	£0.04	£0.04	£3.70	£3.70
ETF	£11.01			£10.15
PN	£55.90			£141.20

ONS = oral nutrition supplements; ETF = enteral tube feeding; PN = parenteral nutrition; GP = general practitioner
* Unit costs are expressed in £/day/patient
† As in the NICE quality standard the cost may include follow-up assessment

Annual activity (number of units per year)

The annual activities associated with nutritional screening, assessment and treatment with ONS, ETF and PN are summarised in Table B.3. Much of this was based on data supplied by the Information Centre (see Appendix for details).

Table B.3 Annual activity of screening, assessment and treatment with ONS, ETF and PN, according to current and proposed pathways†

	Hospital inpatient	Hospital outpatients	Community (new registrations with GP)	Community+ (care home and own home)
Current pathway				
1.Screening	5,691,683	1,559,424	409,786	Not NHS
2.Assessment	743,421	233,914	30,734	4,200
3.Treatment*: ONS	5,984,542	1,883,004	4,149,087	1,134,000
ETF	1,784,211			9,125,000
PN	892,106			353,685
Proposed pathway				
1.Screening	7,880,792	9,356,542	3,688,078	Not NHS
2.Assessment	991,299	311,885	51,223	7,000
3.Treatment*: ONS	7,979,390	2,510,672	6,915,145	1,890,000
ETF	2,069,685			9,855,000
PN	1,034,843			382,155

ONS = oral nutrition supplements; ETF = enteral tube feeding; PN = parenteral nutrition; GP = general practitioner
The shaded areas involve items specifically included for the purposes of sensitivity analyses
† The data are based on the assumptions indicated in Tables B.1, B.2, and B.3 of Appendix B
+ The activity in this column is distinct from that indicated in adjacent column for Community (new registrations with GP)
* Activity is expressed as the number of patient-days of nutritional support in a year

Annual cost of the current and proposed pathways

The cost of each component of the current pathway (unit cost × annual activity; number of units per year) is indicated in Table B.4. For example, the unit cost for screening a hospital inpatient (£1.67; Table B.2) is multiplied by the total activity (number of subjects screened in a year) (5,691,683; Table B3) to give the overall annual cost of screening (£9,505,111; Table B.4). The same procedure is used to calculate the total annual cost of screening in the proposed pathway (£13,160,923; also shown in Table B.4).

The extra cost of implementing the proposed pathway (cost of proposed pathway minus cost of current pathway)

The difference in costs between the two pathways represents the extra investment (extra cost) needed to increase the baseline activity of the current pathway to the one specified in the proposed pathway. For screening of hospital inpatients this amounted to £3,655,812 (£13,160,923 – £9,505,111 (Table B.4) = £3,655,812 (Table B.5)). The extra costs associated with the other components of the pathway were calculated in the same way, and the sum total of these represented the overall extra investment needed to change the current pathway of care to the proposed pathway of care (£61,165,436; Table B.5). Models were also devised to consider the impact of some or even only one of the components (e.g. ONS; see section below on Budget impact analysis).

Since the unit costs are fixed within each care setting and identical for the current and proposed pathways (Table B.2), the difference in total costs between the two pathways are entirely due to differences in activities (Table B.3).

Table B.4 Costs associated with the current and proposed pathways

	Hospital inpatient	Hospital outpatients (new attendances)	GP (new registrations)	Care home anc own home	Total
Current pathway					
1.Screening	£9,505,111	£2,011,657	£754,007	Not NHS	**£12,270,775**
2.Assessment	£12,229,282	£3,847,878	£505,574	£69,090	**£16,651,824**
3.Treatment: ONS	£239,382	£42,572	£15,351,623	£4,195,800	**£19,829,377**
ETF	£19,644,168			£92,618,750	**£112,262,918**
PN	£49,868,709			£49,940,322	**£99,809,031**
Total cost	**£91,486,652**	**£5,902,107**	**£16,611,204**	**£146,823,962**	**£260,823,925**
Proposed pathway					
1. Screening	£13,160,923	£12,069,939	£6,786,063	Not NHS	**£32,016,925**
2. Assessment	£16,305,710	£5,130,504	£842,623	£115,150	**£22,393,987**
3. Treatment: ONS	£319,176	£56,763	£25,586,038	£6,993,000	**£32,954,977**
ETF	£22,787,234			£100,028,250	**£122,815,484**
PN	£57,847,702			£53,960,286	**£111,807,988**
Total cost	**£110,420,745**	**£17,257,206**	**£33,214,724**	**£161,096,686**	**£321,989,361**

ONS = oral nutrition supplements; ETF = Enteral tube feeding; PN = parenteral nutrition; GP = general practitioner
The shaded areas involve items specifically used in sensitivity analyses

Table B.5 Summary of the extra costs associated with implementing the proposed pathway (cost of proposed pathway – cost of current pathway) in hospital and community settings

	Hospital inpatient	Hospital outpatients (new attendances)	Community (GP new registrations)	Community (care home and own home)	Total extra cost
Screening	£3,655,812	£10,058,282	£6,032,056		**£19,746,150**
Assessment	£4,076,428	£1,282,626	£337,049	£46,060	**£5,742,163**
Treatment: ONS	£79,794	£14,191	£10,234,415	£2,797,200	**£13,125,600**
ETF	£3,143,066			£7,409,500	**£10,552,566**
PN	£7,978,993			£4,019,964	**£11,998,957**
Total extra cost	**£18,934,093**	**£11,355,099**	**£16,603,520**	**£14,272,724**	**£61,165,436**

ONS = oral nutrition supplements; ETF = enteral tube feeding; PN = parenteral nutrition; GP = general practitioner
The shaded areas involve items specifically used in sensitivity analyses
† Cost of the proposed pathway minus the current pathway

3. Potential cost savings

A summary of the cost savings obtained in the base case analysis involving both oral nutrition support and artificial nutrition support in all care settings is shown in Table B.6 (see Appendix for details, including the evidence base underpinning the models). The overall cost saving was found to be dominated by the effect of ONS in reducing length of hospital stay. Smaller cost savings were due to the effects of ONS in reducing GP visits, outpatient attendances and hospital admissions. The total potential cost savings indicated in Table B.6 are carried forward into the budget impact analysis, which is presented next.

Nutritional screening was found to be the single biggest extra cost (£19,746,150), accounting for almost twice that associated individually with ONS, ETF and PN.

Table B.6 Potential annual cost saving from reduced healthcare utilisation‡

Cost saving	Amount
Reduced length of hospital stay (oral, mainly ONS)	£89,682,364
Reduced length of hospital stay (ETF+PN)*	£11,122,060
Reduced healthcare use (from extra OP activity)**	£11,355,100
Reduced hospital admissions	£9,717,306
Reduced GP visits	£3,866,242
Reduced OP visits	£906,915
Total potential cost saving	**£126,649,987**
	(£115,527,927)†
	(£101,806,313)‡
	(£112,928,474)+

‡ The values shown do not reflect the net balance. They represent the cost savings (step 2; see Figure B.1), from which the costs (step 1) need to be subtracted to establish the overall net balance or budget impact. The shaded areas represent cost savings only when it is assumed that the financial benefits are equal to additional costs so that the final budget impact or net cost saving remains cost neutral. Without a cost saving from these sources the total potential budget impact is £104,172,827

* Assumed to be equal to the cost of the extra ETF and PN in hospital

** Assumed to be equal to the cost of the extra outpatient (OP) activity, the benefit of which could occur in multiple settings; part of a sensitivity analysis). Other models assumed no cost saving from ETF and PN

† All forms of oral nutrition support only

‡ ONS only

\+ Without oral (non-ONS), i.e. ONS, ETF and PN only

4. Budget (cost) impact analysis

Although the overall budget impact analysis (difference between the investment and financial return) depends on the model used, the results of all five models listed in Table B.7 favoured the proposed pathway by £63–82 million per year. The returns (cost-savings) were 2–5 times greater than the investments (costs) depending on the model.

In analysis 5 (model 5), in which all forms of nutritional support were included in both hospital and community settings, the final budget favoured the proposed pathway by £65,484,550 (£126,649,987 (cost-saving) – £61,165,437 (extra cost) = £65,484,550). In analyses 3 and 4, which excluded home ETF and home PN, the final budget favoured the proposed pathway by even more (£76,914,014). The discrepancy between model 5 on the one hand and models 3 and 4 on the other, simply reflects the cost of providing extra home ETF and home PN in the proposed pathway of model 5 (£11,429,464). The sensitivity analyses, presented later, consider the effect of varying the extra activity due to home ETF and home PN.

Table B.7 A summary of the annual budget impact analysis

Analysis (model)	Treatment and setting	Cost	Cost-saving	Budget impact (net saving)
1	ONS: hospital (IP + OP†) community (GP + CH)	£38,613,913	£101,806,414	£63,192,501
2	Oral*: hospital (IP + OP†)	£19,167,133	£101,037,463	£81,870,330
3	Oral*: hospital (IP +OP†) community (GP + CH)	£38,613,913	£115,527,927	£76,914,014
4	Oral*: hospital (IP + OP†) community (GP + CH) ETF + PN: hospital (IP††)	£49,735,973	£126,649,987	£76,914,014
5	Oral*: hospital (IP + OP†) community (GP + CH) ETF + PN: hospital (IP††) community (GP + CH)	£61,165,437	£126,649,987	£65,484,550

ETF = enteral tube feeding; PN = parenteral nutrition; IP = inpatients; OP = outpatients; GP = general practitioner; CH = care home
*Oral = ONS + other oral treatment following and including the costs of screening and assessment (e.g. dietary counselling, diet modification or fortification)
† assumes that outpatient activity is cost neutral with the extra costs being balanced by the savings so that the budget impact remains unaltered (this assumption is varied in the sensitivity analysis)
†† assumes that the cost of ETF and PN for IP is cost neutral with the extra costs being balanced by the extra savings so that the budget impact remains unaltered (this assumption is varied in the sensitivity analysis)

Table B.8 summarises the major costs and cost savings expressed in relation to the whole population of the country, as well as the population served by a typical clinical commissioning group in England (about 250,000 people in 2011) and the population of a typical parliamentary constituency (about 100,000 - since in 2011–12 there were 533 constituencies serving a population of 53 million).

Using the assumptions specified in the Appendix, Table B.9 shows the approximate contribution of older subjects (≥65 years) to various components of the budget impact analysis. Older subjects generally contributed more to the potential cost-saving than younger subjects. The overall contribution of older subjects to the costs was estimated to be a little less than half using all the models listed in Table B.9, although it varied with specific activities and specific care settings. For example, when considering the hospital inpatient setting, older people accounted for 45% of the extra screening costs (extra costs necessary to implement the proposed pathway), 53% of the extra assessment, and 60% of the extra treatment (with ONS) costs. When considering the hospital outpatient setting, older people accounted for 40% of the costs of screening, assessment and treatment of malnutrition.

The sensitivity analyses involved changing the contribution of people to the number of patient-PN days in hospital (37– 67%), number of patient-ETF days in hospital (52–83%), the cost saving due to use of ONS in hospital (52–67%), and a variety of community activities. These generally had small effects on the costs (±0–2.5% depending on the model) and larger effects on the cost savings (±0–7%) and net cost savings (±0–10%). The largest overall cost savings (±5–7%) and net cost savings (±8–10%) were produced by varying the contribution of older people due to the cost saving produced by ONS in hospital inpatients.

Using the assumptions specified in the Appendix, Table B.9 shows the approximate contribution of older subjects (≥65 years) to various components of the budget impact analysis. Older subjects generally contributed more to the potential cost-saving than younger subjects. The overall contribution

Table B.8 Net cost saving (budget impact) produced by changing from the current to the proposed management pathways of care in hospital (inpatients and outpatients) and community settings (new GP registrations and care homes), with and without home enteral and home parenteral nutrition

	Cost impact (£1000s)		
	per total population‡	**per 100,000 people†**	**per 250,000 people††**
Model 1			
Increase in screening –direct costs	£19,746.15	£36.63	£91.57
Increase in nutritional assessment –direct cost	£5,742.16	£10.83	£27.08
Increase in nutritional support	£13,125.60	£24.76	£61.90
Total extra cost	**£38,613.91**	***£72.84***	***£182.10***
Decrease in activity (mainly secondary care)			
Total cost saving	***£101,806.41***	***£192.04***	***£480.11***
Overall net cost saving	***£63,192.50***	***£119.20***	***£298.01***
Model 2			
Increase in screening –direct costs	£13,714.10	£25.87	£64.67
Increase in nutritional assessment –direct cost	£5,359.05	£10.11	£25.27
Increase in nutritional support	£93.99	£0.18	£0.44
Total extra cost	***£19,167.13***	***£36.16***	***£90.39***
Decrease in activity (mainly secondary care)			
Total cost saving	***£101,037.46***	***£190.59***	***£476.48***
Overall net cost saving	***£81,870.33***	***£154.44***	***£386.09***
Model 3			
Increase in screening –direct costs	£19,746.15	£37.25	£93.12
Increase in nutritional assessment –direct costs	£5,742.16	£10.83	£27.08
Increase in nutritional support	£13,125.60	£24.76	£61.90
Total extra cost	***£38,613.91***	***£72.84***	***£182.10***
Decrease in activity (mainly secondary care)			
Total cost saving	***£115,527.93***	***£217.93***	***£544.82***
Overall net cost saving	***£76,914.01***	***£145.09***	***£362.72***
Model 4* (without home ETF and PN)			
Increase in screening –direct costs	£19,746.15	£37.25	£93.12
Increase in nutritional assessment –direct costs	£5,742.16	£10.83	£27.08
Increase in nutritional support	£24,247.66	£45.74	£114.35
Total extra cost	***£49,735.97***	***£93.82***	***£234.55***
Decrease in activity (mainly secondary care)			
Total cost saving	***£126,649.99***	***£238.91***	***£597.27***

	Cost impact (£1000s)		
	per total population‡	**per 100,000 people†**	**per 250,000 people††**
Overall net cost saving	***£76,914.01***	***£145.09***	***£362.72***
Increase in screening –direct costs	£19,746.15	£37.25	£93.12
Increase in nutritional assessment –direct costs	£5,742.16	£10.83	£27.08
Increase in nutritional support	£35,677.12	£67.30	£168.25
Total extra cost	***£61,165.44***	***£115.38***	***£288.45***
Decrease in activity (mainly secondary care)			
Total cost saving	***£126,649.99***	***£238.91***	***£597.27***
Overall net cost saving	***£65,484.55***	***£123.53***	***£308.82***

‡ The population of England (2011) was 53, 012,456
† Approximates to the population of a parliamentary constituency in England
†† Approximates to the population served by a clinical commissioning group in England
* The results for this analysis (based on analysis 4 of Table B.8) are the same as those obtained assuming that ETF and PN in hospital are cost neutral (analysis 5; Table B.8) and the same as those based on models that exclude these forms of treatment (i.e. oral nutritional support only)
+ Distributed as follows: ONS 54%; ETF 13%; PN 33%
++ Distributed as follows: ONS 37%; ETF 30%; PN 34%

Table B.9 The estimated contribution of older people to the net cost-saving‡

Analysis	Treatment and setting		% due to older people (≥65 years)		
			Cost	Cost-saving	Budget impact (net saving)
1	ONS:	all settings	47	56	61
2	Oral*:	hospital (IP + OP†)	44	58	61
3	Oral*:	hospital (IP +OP†) community (GP + CH)	47	57	63
4	Oral*: ETF + PN:	hospital (IP + OP†) community (GP + CH) hospital IP††	49	57	63
5	Oral*: ETF + PN:	hospital (IP + OP†) community (GP + CH) hospital (IP††) community (GP + CH)	48	57	66

‡ The absolute net costs, cost savings and budget impact are shown in Tables B.7 and B.8. The assumptions are indicated in the Appendix which also presents the results of the sensitivity analyses
ETF = enteral tube feeding; PN = parenteral nutrition; IP = inpatients; OP = outpatients; GP = general practitioner; CH = care home
*Oral = ONS + other oral treatment following and including the costs of screening and assessment (e.g. dietary counselling, diet modification or fortification)
† assumes that outpatient activity is cost neutral with the extra costs being balanced by the savings so that the budget impact remains unaltered (this assumption is varied in the sensitivity analysis)
†† assumes that the cost of ETF and PN for IP is cost neutral with the extra costs being balanced by the extra savings so that the budget impact remains unaltered (this assumption is varied in the sensitivity analysis)

of older subjects to the costs was estimated to be a little less than half using all the models listed in Table B.9, although it varied with specific activities and specific care settings. For example, when considering the hospital inpatient setting, older people accounted for 45% of the extra screening costs (extra costs necessary to implement the proposed pathway), 53% of the extra assessment, and 60% of the extra treatment (with ONS) costs. When considering the hospital outpatient setting, older people accounted for 40% of the costs of screening, assessment and treatment of malnutrition.

The sensitivity analyses involved changing the contribution of people to the number of patient-PN days in hospital (37– 67%), number of patient-ETF days in hospital (52–83%), the cost saving due to use of ONS in hospital (52–67%), and a variety of community activities. These generally had small effects on the costs (±0–2.5% depending on the model) and larger effects on the cost savings (±0–7%) and net cost savings (±0–10%). The largest overall cost savings (±5–7%) and net cost savings (±8–10%) were produced by varying the contribution of older people due to the cost saving produced by ONS in hospital inpatients.

To complement the budget impact analyses based on models 1–5 (Tables B.7, B.8 and B.9), all of which assumed that nutritional support was provided to about 85% of people at *high risk* of malnutrition only, further analyses were undertaken to examine the effect of providing nutritional support to 85% of patients with *medium* + *high risk* of malnutrition. Using the first approach the net cost savings favouring the proposed pathway were found to be about 50% greater than those reported by NICE (2012); and using the second approach it was estimated to be 300–500% greater, depending on the model used. These results are shown diagrammatically in Figure B.2, which also demonstrates a further point.

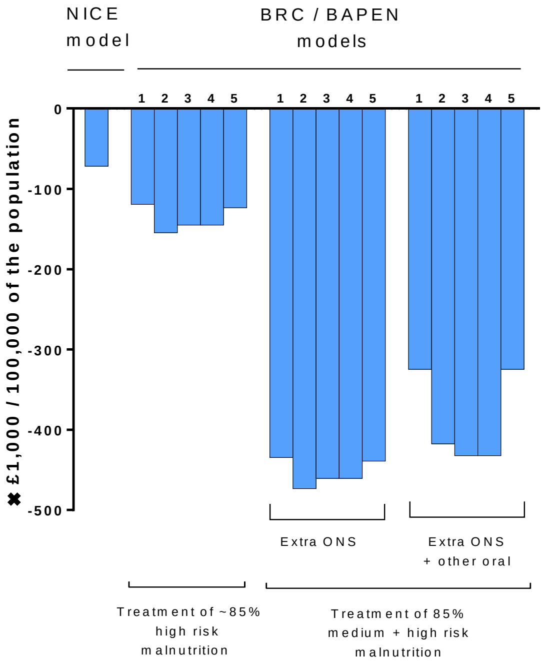


Figure B.2 Net cost saving according to type of model, severity of malnutrition treated, and whether the extra treatment associated with medium-risk malnutrition involved ONS alone or ONS plus other forms of oral nutritional support. NICE = National Institute for Health and Care Excellence; BRC / BAPEN = National Institute for Health Research Southampton Biomedical Research Centre / British Association for Parenteral and Enteral Nutrition. The numbers at the top of the bars refer to the type of model used (1 = ONS in all settings; 2 = oral (ONS and non-ONS) in hospital inpatients and outpatients; 3 = oral (ONS and non-ONS) in hospital and community settings; 4 = as for 3 + enteral tube feeding and parenteral nutrition in hospital; 5 = as for 3 + enteral tube feeding and parenteral nutrition in hospital and community settings. 'Extra ONS' refers to the use of extra ONS to support subjects with medium risk of malnutrition (without dietetic referral) and 'Extra ONS + other oral' refers to the use of extra ONS plus other forms of nutritional support (with referral to a dietitian), using the proportions specified in the base case model.

The variation in net cost-saving between the five different models was found to be relatively small compared to the discrepancy between the two approaches (irrespective of whether ONS was given to all subjects with medium risk of malnutrition or only a proportion of them, the remainder being given non-ONS oral nutrition support).

A breakdown of the costs associated with treating more malnourished subjects using one of the models (model 5) is shown in Figure B.3. Nutritional screening contributed more costs than assessment and more costs than individual treatments with parenteral nutrition, enteral nutrition and oral nutrition supplements in all care settings.

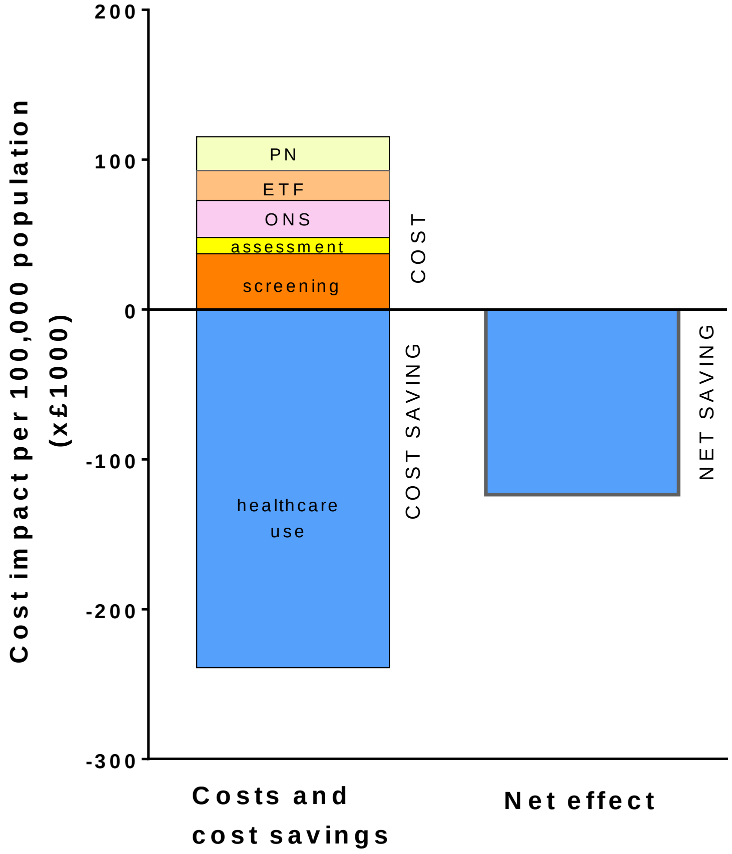


Figure B.3 The costs, cost savings and budget impact (net effect) of providing nutritional support to ~85% of subjects with high risk of malnutrition (model 5). PN = parenteral nutrition, ETF = enteral tube feeding, ONS = oral nutritional supplements.

5. Sensitivity analysis

Sensitivity analyses on budget impact were undertaken using various models for three main reasons:

1. To examine the effects of uncertainties in assumptions on the budget impact analysis and to identify key areas of research that are needed to make the model more robust
2. To increase understanding of the relationships between input and output variables
3. To make recommendations more understandable and convincing e.g. by integrating economic considerations with clinical practice.

The sensitivity analyses examined different assumptions between and within models.

Differences in assumption between models

Table B.10 shows the results of two models of patients with high risk of malnutrition, which complement those shown in Tables B.7–B.9. Model A is the same as model 2 (Tables B.7–B.9) with the exception that it involves only hospital inpatients. The proportion of patients given ONS and oral non-ONS nutrition support remains unchanged, and the assumption that oral non-ONS nutritional support reduces length of hospital stay by only half that achieved by ONS also remains unchanged. In Model B only the ONS component is included. The additional cost saving due to the inclusion of oral non-ONS nutrition support in model A is £11,844,840 (equivalent to 17% of that due to ONS alone), which is substantial.

Table B.10 An example of assessing the impact of a variable (oral treatment following dietetic referral) by including it in an existing model‡

Model	Treatment and setting	Cost	Cost-saving	Budget impact (net saving)
A	ONS: hospital (IP)	£7,812,033	£77,837,523	£70,025,490
B	Oral*: hospital (IP)	£7,812,033	£89,682,364	£81,870,330
A	ONS: hospital (IP)	£7,812,033	£77,837,523	£70,025,490
Difference (B-A)	Oral nutrition (non ONS) (IP)	£0	£11,844,841†	£11,844,840†

‡ In this analysis it was assumed that oral treatment following referral to a dietitian is only half as effective in reducing length of hospital stay as ONS, but different assumptions can be tested using the same procedure
*Oral = ONS + other oral treatment following and including the costs of screening and assessment (e.g. dietary counselling, diet modification or fortification)
† minor difference between the two values is due to rounding
IP = inpatients

Similar procedures were undertaken to establish the effect of including other treatments. For example, the only difference between analyses 4 and 5 in Table B.9 (£11,429,464) is the addition in model 5 of home ETF and PN (8% higher activity in the proposed than the current pathway of care). This difference is also substantial, representing 15% of the net cost saving associated with model 4.

Differences in assumptions within models

Differences in assumptions within models can produce results that complement those between models.

For example, in model B (Table B.10) it was assumed that that non-oral ONS oral nutrition support was half as effective in reducing length of hospital stay as ONS, so that the budget impact was less favourable by £11,844,840. If it is assumed that non-ONS oral nutrition support has no cost and no effect on length of hospital stay, the net gain of £11,844,840 is lost and the overall the result is the same as that for model A (Table B.10). If on the other hand it is as effective or more effective than ONS the additional cost saving doubles or more than doubles (≥£23,689,680).

All the costing models were subjected to a series of one way sensitivity analyses involving assumptions about both costs and cost savings. Table B.11 shows the results of one set of such analyses obtained using model 5, which includes the use of both oral (ONS and non-ONS) and artificial nutrition support (ETF and PN) in all care settings. The second column in Table B.11 indicates the assumptions used in the base case analysis, and the third and fourth columns indicate the lower and upper limits used in the sensitivity analyses. The other columns display the results of the cost analysis as a proportion of the base case analysis. Expressed in this way the results can apply to populations of different sizes, including the entire population of England or populations served by primary care groups of parliamentary constituencies. The absolute costs and cost savings and the net balance associated with the base case analysis are summarised in a footnote to the table. The absolute changes in results caused by varying the assumptions can be calculated by multiplying the proportional changes (shown in the Table) with absolute base case values (shown in the footnote). The data in Table B.11 were then used to construct Figure B.4, to give a visual overview of the quantitative effects of different input variables (due to variation in assumptions) and to readily identify those variables that have large effects on the budget impact and those that have only small effects. Figure B.6 shows that the results from this model generally co-vary with those obtained using five other models (provided of course that the same input variables are included in all the other models).

The effect of varying input parameters incurring extra costs

The net cost saving (budget impact) was found to be sensitive to variations in hospital admission rates within the ranges likely to apply locally or regionally (e.g. ±20% variations in admission rate was found to affect the final budget by ±25% in model 5). The model was also found to be sensitive to variations in the prevalence of malnutrition on admission to hospital, which can be influenced by geographic location[67] and season[25]. As little as a 3% increase in the prevalence of malnutrition (from 28.3% to 31.3%) was sufficient to increase the budget impact (net cost saving) by 13.8%, whereas a 3% decrease reduced the budget impact by 13.8%. In both of these examples the more favourable budget impact was associated with treatment of more malnourished inpatients, and the less favourable budget impact with treatment of fewer malnourished inpatients.

The models were found to be fairly sensitive to variations in the time taken to screen. Changing the base case value of 5 minutes by ±4 minutes affected the final monetary balance by ±3.6% to ±12.3% depending on model. In contrast, the models were not sensitive to variations in the prevalence of malnutrition among subjects newly registering with their GP and those admitted to care homes, nor were they sensitive to variations in the pay scale of healthcare workers (±1 band) undertaking nutritional assessment.

In the base case calculations it was assumed that the cost of non-ONS oral nutritional support in malnourished subjects was the same as the cost of hospital food in non-malnourished patients (see Appendix). However, even if it is assumed that the cost is about 50% greater than that of the food itself (ingredient cost), the budget impact is affected by only 1–2%). Certain sensitivity analyses were not carried out, either because of their trivial overall costs (implying a trivial effect on the budget impact) or because the models assumed that they were cost neutral (e.g. sensitivity on the duration of ETF and PN in hospital was not carried out).

The effect of varying input parameters on net cost savings

The effects of varying the assumptions about potential cost savings on the final budget (net cost savings or net balance) are summarised in Table B.11 and Figures B.4, B.5 and B.6. The single most important factor is the reduction in the length of hospital stay by ONS. Table B.11 and Figure B.5 show the financial consequences (net balance) of varying the base case value of 13.9% reduction in hospital stay, which was obtained from a random effects meta-analysis of randomised controlled trials (see Glossary) (see also Appendix: Calculating potential cost savings). A change by ±25% of this value (i.e. 13.9 ± 3.475%, or from 10.425% to 17.375%) affects the final budget by as much as ±34%. Figure B.5 shows that when the value was varied from 0% to 30%, so that it included the 95% confidence interval (95% CI) obtained from the meta-analysis,the effect on the budget was found to be linear over the entire range. The horizontal dotted line in Figure B.5 indicates the cost-neutral budget which is achieved when length of hospital stay is reduced by ONS by only 1.98% (equivalent to 4.8 hours during a 10-day spell in hospital) using model 2 (ONS in the hospital setting only) and 3.75% using model 5 (oral and artificial nutrition support (ETF and PN) in all settings), and between 1.98–3.75% with the other models.

Table B.11 Sensitivity analysis involving model 5 which involves oral and artificial (ETF and PN) nutrition support in all care settings

Variable changed	Assumption			Cost† % change			Cost saving† % change			Net cost saving† % change		
	Base case	Lower limit	Higher limit	Base case	Lower limit	Higher limit	Base case	Lower limit	Higher limit	Base case	Lower limit	Higher limit
COSTS												
Activity												
Number of IP admissions	8,756,436	-20% B	+20% B	0.0	-6.2	6.2	0.0	-15.9	15.9	0.0	-25.0	25.0
Number of OP attendances	10,396,158	-20% B	+20% B	0.0	-3.7	3.7	0.0	-1.8	1.8	0.0	0.0	0.0
Number of new GP registrations	4,097,864	-20% B	+20% B	0.0	-5.4	5.4	0.0	-1.8	1.8	0.0	1.5	-1.5
Number of care home admissions	120,000	-20% B	+20% B	0.0	-0.9	0.9	0.0	-0.5	0.5	0.0	0.0	0.0
ETF hospital proposed pathway	172,474	-16% B	+16% B	0.0	-5.1	5.1	0.0	-2.5	2.5	0.0	0.0	0.0
PN hospital proposed pathway	86,837	-16% B	+16% B	0.0	-13.0	13.0	0.0	-6.3	6.3	0.0	0.0	0.0
ETF community proposed pathway	27,000+	-8% B	+8% B	0.0	-12.1	12.1	0.0	0.0	0.0	0.0	11.3	-11.3
PN community proposed pathway	1,047+	-8% B	+8% B	0.0	-6.6	6.5	0.0	0.0	0.0	0.0	6.1	-6.1
Prevalence of malnutrition (%)												
Hospital inpatients	28.3%	25.3%	31.3%	0.0	-2.6	2.6	0.0	-8.4	8.4	0.0	-13.8	13.8
Hospital outpatients	15.0%	10.0%	20.0%	0.0	-0.7	0.7	0.0	-0.3	0.3	0.0	0.0	0.0
New registrations at GP clinics	7.5%	4.0%	11.0%	0.0	-8.1	8.1	0.0	-4.3	4.3	0.0	-0.7	0.7
Care homes	35%	30%	40%	0.0	-0.7	0.7	0.0	-0.3	0.3	0.0	0.0	0.0
Screening												
Time taken to screen	5 min	-80% B	+80% B	0.0	-25.8	25.8	0.0	-6.4	6.4	0.0	11.8	-11.8
Pay band according to setting	Band 3-5	-1 band	+1 band	0.0	-4.5	6.5	0.0	-1.0	1.3	0.0	2.3	-3.6
Assessment												
Duration	45 min	-33.3% B	+33.3% B	0.0	-3.1	3.1	0.0	-0.3	0.3	0.0	2.3	-2.3
Pay band	Mid-band 5	Mid-band 4	Mid-band 6	0.0	-1.5	2.1	0.0	-0.2	0.2	0.0	1.1	-1.5

Variable changed	Assumption			Cost† % change			Cost saving† % change			Net cost saving† % change		
	Base case	Lower limit	Higher limit	Base case	Lower limit	Higher limit	Base case	Lower limit	Higher limit	Base case	Lower limit	Higher limit
Treatment												
Unit cost of nutritional support												
ONS hospital (IP + OP)	£0.04	-25% B	+25% B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ONS community (GP + CH)	£3.7	-25% B	+25% B	0.0	-5.3	5.3	0.0	0.0	0.0	0.0	5.0	-5.0
ETF hospital	£11.01	-25% B	+25% B	0.0	-1.3	1.3	0.0	-0.6	0.6	0.0	0.0	0.0
PN hospital	£55.9	-25% B	+25% B	0.0	-3.3	3.3	0.0	-1.6	1.6	0.0	0.0	0.0
ETF community	£10.15	-25% B	+25% B	0.0	-3.0	3.0	0.0	0.0	0.0	0.0	2.8	-2.8
PN community	£141.2	-25% B	+25% B	0.0	-1.6	1.6	0.0	0.0	0.0	0.0	1.5	-1.5
Duration of treatment+												
ONS Hospital (IP + OP)	7 days	-25% B	+25% B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ONS community (GP + CH)	90 days	-25% B	+25% B	0.0	-5.3	5.3	0.0	0.0	0.0	0.0	5.0	-5.0
COST SAVINGS												
ONS												
Reduction in LOS (ONS use)	13.9%	-25% B	+25% B	0.0	0.0	0.0	0.0	-17.7	17.7	0.0	-34.2	34.2
Reduced admissions/subject/y	0.11	-50% B	-50% B	0.0	0.0	0.0	0.0	-3.8	3.8	0.0	-7.4	7.4
Reduced appointments/subject/y	0.155	-50% B	-50% B	0.0	0.0	0.0	0.0	-0.4	0.4	0.0	-0.7	0.7
Reduced GP visits/subject/y	2	-50% B	-50% B	0.0	0.0	0.0	0.0	-1.5	1.5	0.0	-3.0	3.0
Oral diet (non-ONS)												
Oral diet (all settings) % of ONS*	50%	0%	100%	0.0	0.0	0.0	0.0	-10.8	10.8	0.0	-21.0	21.0
Oral diet (hospital only) % of ONS*	50%	0%	100%	0.0	0.0	0.0	0.0	-9.4	9.4	0.0	-18.1	18.1

B = Base case analysis e.g. for -25% B = 75% of the value used for the base case analysis
† The absolute values for cost are £61.165 million for the entire population of England, £115.4 thousand per 100,000 of the population and £288.4 thousand per 250,000 of the population. For cost savings the corresponding values are £126.486 million, £238.6 thousand and £596.5 thousand, and for net saving £65.485 million, £123.5 thousand and £308.8 thousand, respectively
+ Since ETF and PN in hospital were assumed to be cost neutral (see section on Assumptions), sensitivity analyses on the duration of feeding ETF and PN are not included
*The effect is expressed as % of that produced by ONS

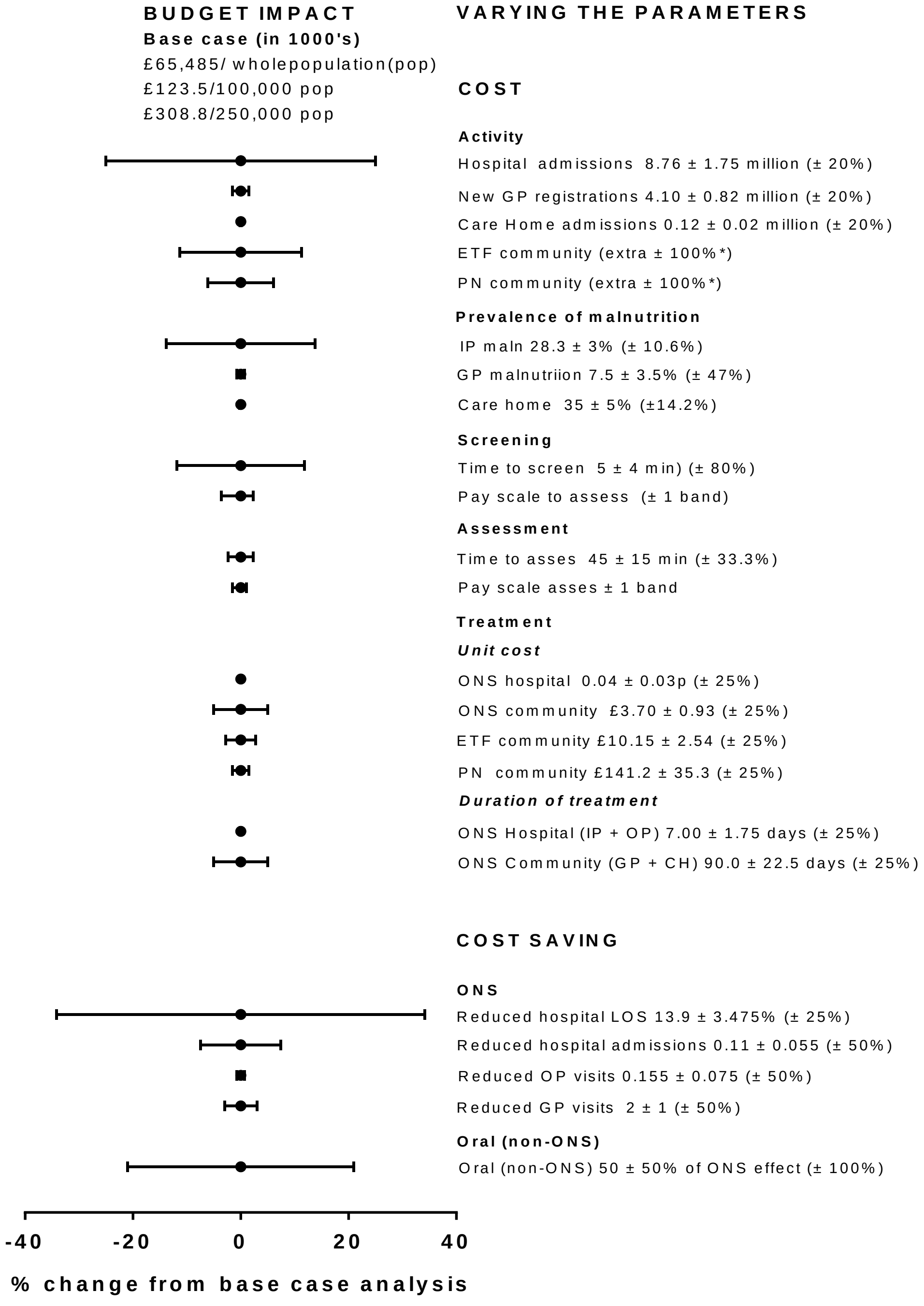


Figure B.4 Sensitivity analysis involving model 5 showing percentage changes in budget impact when the input variables affecting cost and cost saving are varied to the extent shown (right column) (constructed using results shown in Table B.11).

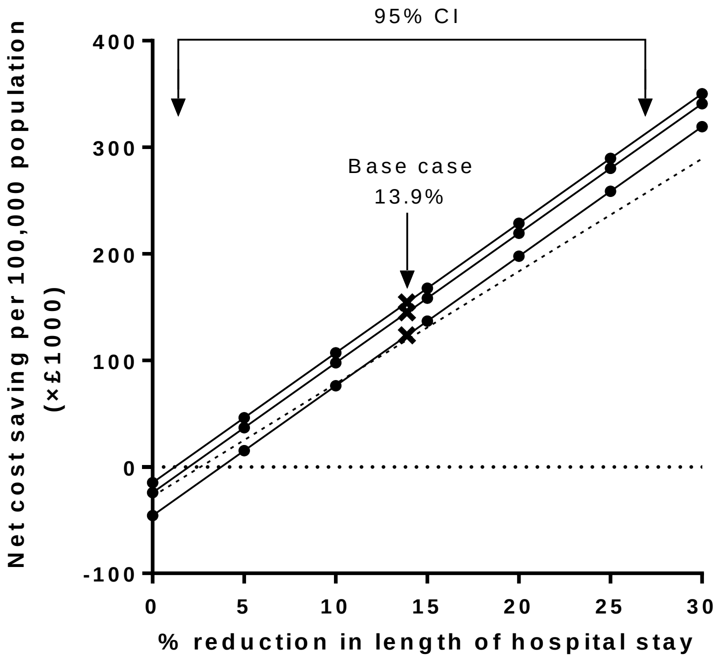
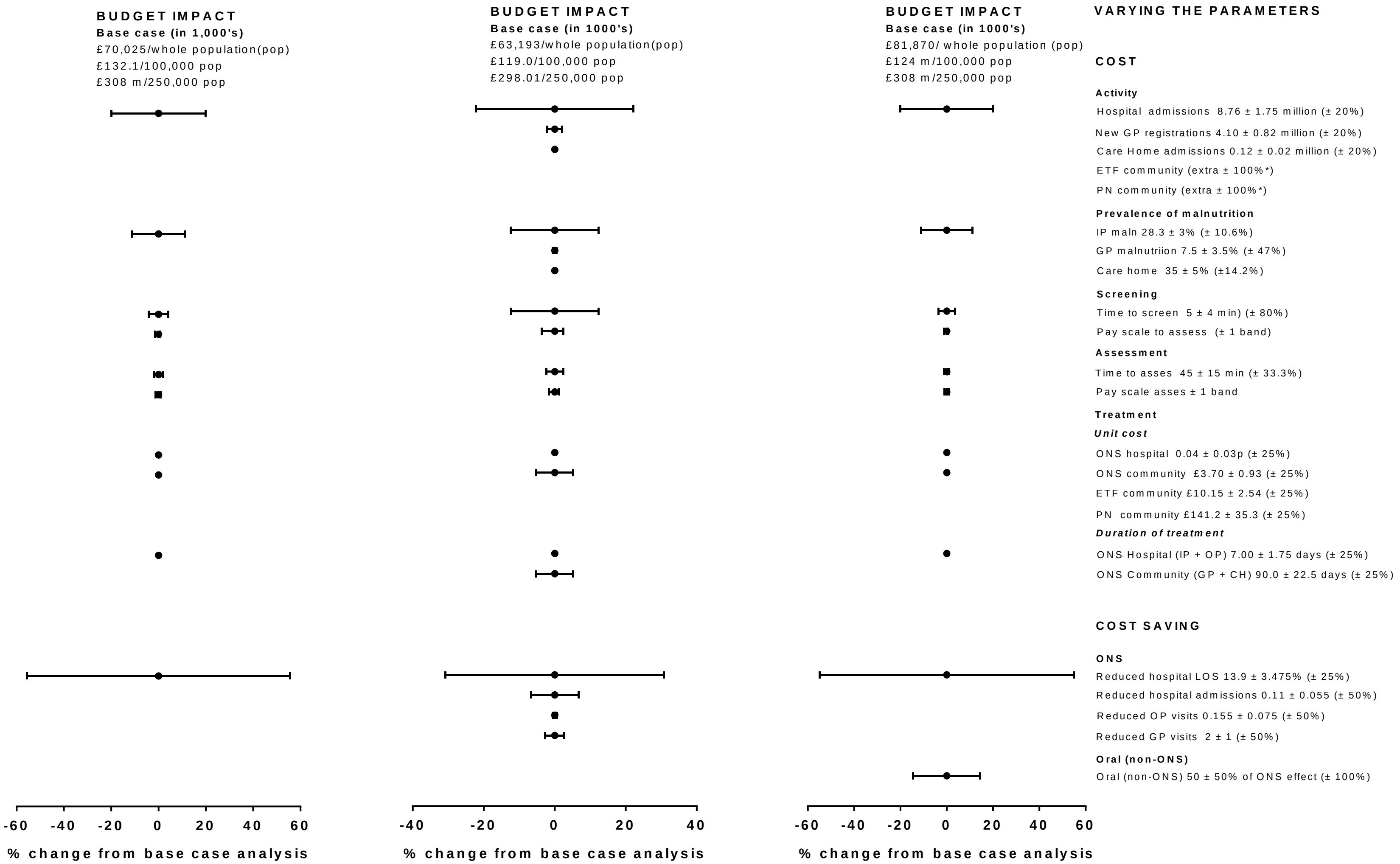


Figure B.5 Sensitivity analysis produced by altering the % reduction in length of hospital stay from the mean value of 13.9% obtained from the meta-analysis (indicated by the crosses). The three parallel lines represent data from models (analyses) 2 and 3 (upper), model 4 (middle), and model 5 (lower). The diagonal dotted line originates from model 1 which involves exclusive use of ONS in all care settings.

Varying the assumptions about the effectiveness of oral (non ONS) nutritional support in malnourished patients in hospital (following specialist/dietetic advice) was also found to have a substantial influence on the final budget (e.g. up to ±21% when all care settings were considered together using model 5). The cost saving associated with the use of ONS and oral (non-ONS) nutrition support arise mainly from the hospital setting. Those from the community were predominantly due to reduced hospital admissions from ONS use (Table B.11 and Figure B.5). The smaller cost savings of interventions in the community were partly due to the smaller number of subjects and partly to smaller cost savings per subject (from reduced GP visits, hospital admissions, and outpatient attendances).

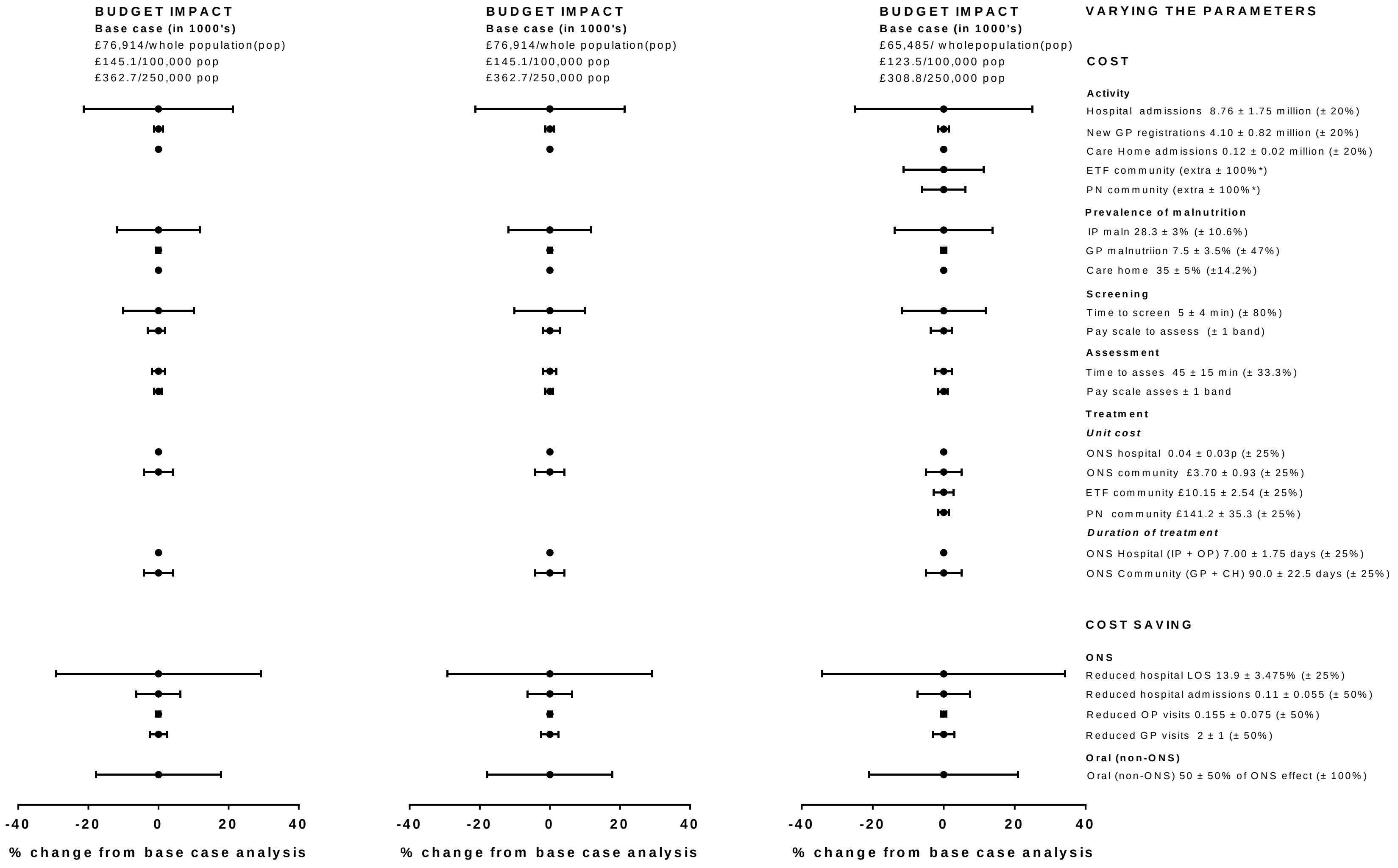
Sensitivity analyses associated with the other models are shown diagrammatically in Figure B.6. The input variables generally co-varied with each other, so that those that had a large impact in one model also had a large effect in the other models and vice versa. However, it was not possible to compare the impact of certain variables, such as the activity of home ETF and home PN because these variables were included in only one of the models. The figure does not show all possible types of sensitivity analysis and does not include ETF and PN in hospital, which were assumed *a priori*, to be cost neutral. A further consideration concerns the possibility of inappropriate use of nutritional support, which is also not included in Figure B.6. For example, if ONS was used inappropriately in up to 10% of patients in all care settings with no financial benefit (and also no harm), the net cost savings would be reduced by 10–16%, depending on the model used.



ONS: hospital inpatients

ONS: all settings

Oral: hospital in- and out-patients



Oral: all settings   Oral: all settings and ETF+PN hospital   Oral and ETF+PN: all settings

Figure B.6 Sensitivity analyses showing changes in budget impact when the input variables affecting cost and cost saving are varied to the extent shown (right column).

6. Discussion

This budget impact analysis suggests that changing the current pathway of nutritional care to one that more fully incorporates the NICE national guidelines/quality standard on nutritional support in adults, results not only in better quality of care but also in a substantial net cost saving. The returns were generally found to be two to three-fold greater than the investment and as high as five-fold in a model involving only ONS. Different models were used to undertake cost impact analyses for three reasons:

1. They allowed examination of the effects of particular types of interventions, such as ONS alone in all care settings (models 1), oral (ONS + non-ONS) alone in all care settings (model 3), and a combination of ONS with artificial nutritional support in hospital (model 4) and hospital plus community settings (model 5). The different models may be of varying interest to healthcare professionals, policy makers and manufactures of specific nutritional products.

2. There are important uncertainties about the effects of certain types of interventions on resource use (e.g. effect of ETF and PN on length of hospital stay), and also uncertainties about the optimal frequency with which ETF and PN should be used. Such uncertainties were examined using different models that complement each other.

3. Since much of home ETF and home PN is used primarily to save lives (or to improve or attenuate deterioration in quality of life), rather than to save money, the value of such treatments may be better examined using a cost-effectiveness analysis, (e.g. cost-utility analysis involving quality adjusted life years or QALYs). Therefore, the budget impact analysis involving home ETF/PN was undertaken separately using model 5.

Despite these considerations, however, the final cost impact of the different models was found to vary by relatively little, the lowest net cost saving (£63,192,501; models 1; Table B.7) being 72% of the highest (£81,870,330; model 5).

The budget impact analysis was dominated by the cost saving due to reduced hospitalisation, which was in turn entirely or predominantly due to the effect(s) of ONS, depending on the model used. Part A of this report shows that secondary care accounted for most of the healthcare expenditure in the general population of adults and most of the healthcare expenditure in the population of malnourished adults (Table A.8). Part B of this report found that when the care pathways recommended in the NICE guidelines/quality standard are implemented, the hospital setting accounted for most of the cost savings (Table B.6). However, to implement the clinical guidelines/quality standard, it is important that they are understandable and available to a wide range of healthcare workers and patients/carers across all care settings. The implementation can also be facilitated if there are financial benefits, which are expressed in ways that are directly relevant to both local and national economies. For this reason the results of the budget impact analyses were expressed in relation to the population of the country as a whole, per 250,000 of the population, which approximates to the population served by a typical clinical commissioning group, and per 100,000 of the population, which approximates to the population served by a parliamentary constituency. Since the cost savings reported in this document were based on calculations in a restricted population of malnourished subjects, implementation of an integrated and coordinated nutritional strategy to prevent and treat malnutrition in the wider community of malnourished subjects (using food, ONS and other forms of nutritional support) could produce even further cost savings.

Some of the most important findings of the present work emerged from the sensitivity analyses, which identified variables that had potentially large effects on the budget and others that had only minor effects. A more favourable budget impact can occur either through reduced costs and increased cost savings or both. The factors affecting costs and cost savings are discussed below.

Factors affecting costs

Since hospital admissions are expensive, accounting for the largest single expenditure of the costing model it is not surprising that variations in the rate of admissions also had a large impact on the final budget. As national data on hospital admission rates provided by the Information Centre were considered to be generally robust, the sensitivity analyses were primarily undertaken to examine the effects of local variations in admission rates on local economies. It was found that the net cost savings were fairly sensitive to admission rates, with ±20% variation in admission rates producing a net cost saving of ±20–25%, depending on the model used to examine the effect.

The prevalence of malnutrition was also considered to be generally robust in the country as a whole, but it is known to vary between hospitals, geographic locations[67] and seasons[25]. The costing models were particularly sensitive to variations in the prevalence of malnutrition on admission to hospital, since as little as 3% increase (from 28.3% to 31.3% in the admission prevalence) favourably influenced the budget by 11.1–13.8%, depending on the model used. This again is understandable since most of the net cost savings predicted by the models are due to the treatment of malnourished subjects in the expensive hospital environment. Treatment of more malnourished patients in this setting would be expected to produce more benefits. Such considerations are also relevant to the concept of the care gap (Figure B.7). It has been suggested that when there is a large gap between the current and desirable quality of care, interventions are likely to produce larger clinical benefits than when the gap is small [68](especially if elimination of a small care gap requires a disproportionately large investment). The present analysis extends this concept into economic outcomes. It suggests that appropriate interventions to combat a large amount of untreated malnutrition (large care gap) produce more favourable cost savings, than when they are used to combat little untreated malnutrition (small care gap).

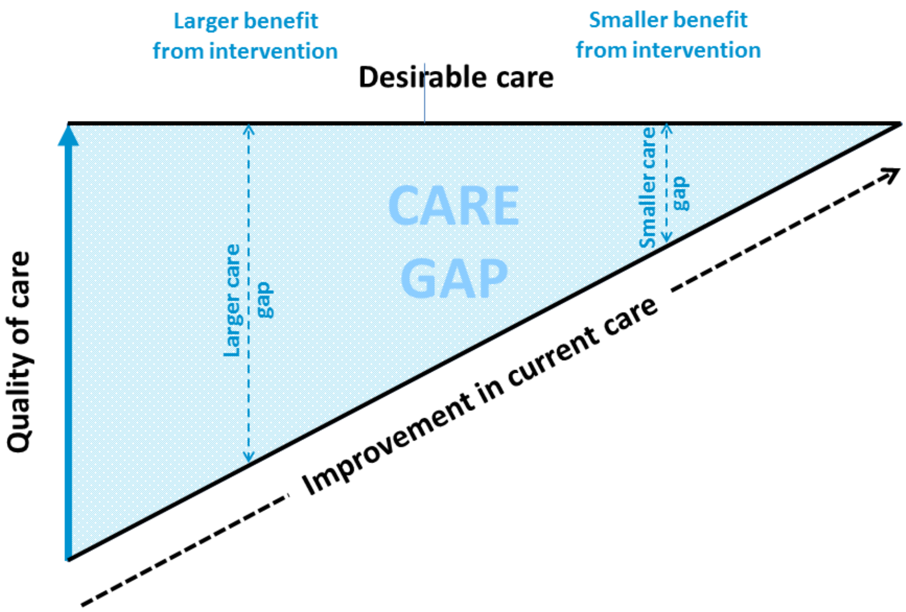


Figure B.7 The effect of improvement in clinical care according to the prevailing care gap (based on Elia, Zelllipour and Stratton[68]).

Variation in the time taken to screen people was also found to have a substantial effect on the costs and the final budget. In the base case analysis the cost of nutritional screening in all care settings was found to be greater than that of nutritional assessment, and greater than that of individual treatments (ONS, ETF, or PN) in all care settings. In the base case analysis it was assumed that nutritional screening took 5 minutes to perform, which is typical of the time taken using paper versions of 'MUST'[69], the most widely used screening procedure in England. However, in the sensitivity analysis in which the time to screen was varied from 1 to 9 minutes (5 ± 4 minutes), the final budget was affected by ±3.6% to ±12.3% depending on the model used. The upper limit for the time taken to screen took into account the extra time required to screen certain groups of patients, such as those with neuromuscular problems, who may require help to get up, take their shoes off, and stand in the correct position to have their height and weight measured. The lower limit was partly based on studies of using standard versions of 'MUST', which have reported a screening time of <2 minutes[69, 70]. It was also partly based on studies in which healthcare workers took even less than a minute to screen patients using an automated electronic system that can calculate, display, print and/or transmit the results electronically into the patient records[29]. Furthermore, it has been reported that certain groups of hospital outpatients can self-screen reproducibly and accurately in a little more than one minute. This could potentially reduce or replace health professional screening, with further reduction in costs. Future research should aim to explore potential cost savings that may result from self-screening and methods that improve the reproducibility and accuracy of screening.

In contrast to the above factors which had a moderate to large effect on the budget, the following variables were found to have relatively little effect on the budget: unit cost of ONS and duration of treatment with ONS in hospital; the prevalence of malnutrition in patients newly registering with a GP; and prevalence of malnutrition in subjects admitted to care homes. Since these items generally contributed little to the overall cost of care, it is not surprising that even large variations in the assumptions assigned to these variables had little impact on the overall budget.

Factors affecting cost-savings

The sensitivity analysis identified two interventions producing potentially large cost savings. The first was the reduction in length of hospital stay due to the administration of ONS to malnourished subjects. The random effects meta-analysis of controlled trials of malnourished hospitalised patients found that length of hospital stay was reduced by a mean of 13.9%. Accordingly, this figure was used in the base case analyses of all models. However, the 95% confidence interval obtained from the meta-analysis was large due to various factors, including differences in the designs of randomised controlled trials, underlying conditions causing malnutrition, countries in which the studies were undertaken, and the year of study publication (which spanned more than 20 years). During this period there were substantial changes in clinical practice, including a substantial reduction in the mean length of hospital stay. Furthermore, some of the randomised controlled trials involved subjects who were predominantly or exclusively older (mean age ≥65 years), while others involved younger subjects (mean age <65 years), who are known to generally have a shorter length of hospital stay than older subjects. However, when the reduction in the mean length of stay is expressed as a proportion of the control group within each study the results in older and younger groups become more comparable (see Appendix). For this reason, the meta-analysis was based on percentage changes in length of hospital stay rather than on the absolute changes in days. Even so, it is clear that more research is required to examine the effects of ONS in different groups of malnourished patients, the extent to which the study populations included in the meta-analysis reflect those encountered in routine clinical practice, and the robustness of data used in the budget impact analyses.

The effect of oral non-ONS nutrition support on healthcare use is more uncertain than that of ONS. In addition, there is considerable variation in the use of these two forms of nutritional support within and between care settings and also in the choice between them. From a nutritional perspective there is no major reason to suppose that ingestion of the same amounts of extra nutrients from a diet as opposed to ONS would produce significantly different effects on healthcare utilisation. However, the effects may differ if fewer extra nutrients or less balanced nutrients are taken from a diet or snacks than from ONS[71]. The base case analyses of the economic models assumed that oral non-ONS nutrition support, following assessment by a specialist, was only half as effective as ONS in reducing healthcare use, but the sensitivity analyses examined a range of possibilities from no effect to as great or greater effect than that produced by ONS. The economic outcomes were substantially affected by changing the assumptions concerning this variable, as can be gleaned from Figures B.4 and B.6. Therefore, the economic models could be made more robust if additional evidence-based information on the effect of dietetic counselling/oral diet in malnourished subjects on healthcare use became available.

The models used assumed that appropriate nutritional support was provided appropriately to those identified as being malnourished or at risk of malnutrition. Inappropriate use of nutritional support in those that are not malnourished (e.g. from inaccurate screening or assessment) or who do not stand to gain clinical benefits from nutritional interventions was also considered. Inappropriate use of ONS in 10% of the malnourished population in all care settings reduced the net cost savings by 10-16%, depending on the model used. Education and training in screening, assessment and monitoring could help reduce any inappropriate use of ONS, including situations when ONS are no longer needed.

Budget impact

From the above discussion it is clear that a more favourable final budget can be obtained by a combination of factors that reduce costs and increase cost savings. On the basis of the budget impact schemes linked to NICE clinical guidelines/quality standard, nutritional support in adults was ranked as the third highest net cost saving, surpassed only by the treatment of hypertension (Clinical Guideline 34 (CG34)) and use of long-standing contraception (Clinical Guideline 30 (CG30)). The present analyses on nutritional support in adults suggest 50% greater cost saving than that reported by the 2012 NICE report, if about 85% of people with high risk of malnutrition were managed appropriately in the settings and subject groups recommended by the NICE guidelines/quality standard. The analyses also suggests that the cost saving could be as much as 300–500% greater than that reported by NICE if 85% of people with medium + high risk of malnutrition were managed appropriately. Although the NICE documents did not consider a breakdown of the economic model according to age categories, this report indicates that older adults accounted about half of the costs of the intervention (cost of proposed pathway minus the cost of current pathway in adults) are due to those aged ≥65 years (comparable to the distribution of the total cost of malnutrition in adults (section A; Figure A.5), and more than half of the net cost saving (Table B.9).

Recently two systematic reviews on the cost and post-effectiveness of using standard ONS have become available, one involving the hospitals[72] and the other in the community and care homes[73]. These support the assumptions and findings of the economic model used in this report. In the hospital setting, ONS was found to not only found to be cost effective, but to also to produce a net cost saving. These economic benefits were associated with significant reductions in mortality and morbidity. In the community setting ONS produced an overall cost advantage favouring the ONS group or near neutral balance. These economic outcomes were associated association with improved clinical and functional benefits, such as, such as reduced frequency of falls and infections, and improvement in quality of life and functional limitations.

Despite the cost savings, they represent only a small proportion (0.8–3.3%; 5 models in Figure B.2) of the total healthcare cost of malnutrition in adults (£14.4 billion; Part A of this report). Several explanations can be put forward to account for this:

1. The total cost of disease-related malnutrition does not represent the cost of malnutrition alone. It is difficult to separate the effects of malnutrition from the associated disease because each can be a cause and consequence of the other. Nevertheless, treating disease and its consequences is expensive, and many chronic conditions are only partially responsive to nutritional support.

2. The budget impact analyses were based on models that do not involve all malnourished people. Indeed, all models excluded the majority of adults attending outpatient clinics (they included only new outpatient attendances representing ~10% of the total), the majority of patients treated by their general practitioners (the models included only those newly registering with a GP in a year, representing only about ~10% of the total), and probably the majority of patients treated in care homes (only those newly admitted during the year were included in the model). The models also excluded a range of other patient groups, including all children and adults with maternity or obstetric problems.

3. The estimated total cost of malnutrition, established in the first part of this report, is based on the cost of all adults, including those receiving appropriate nutritional care, whereas budget impact analysis concerns only the further cost saving obtained by appropriate care of a proportion of those malnourished people. If a large proportion of people are already receiving appropriate care the scope for cost saving is attenuated. For example, the majority of malnourished hospital inpatients (which dominated the costs and cost savings) were already managed in the current pathway of care (65% screening), leaving relatively little room for further interventions to produce further cost savings. Indeed, in the first series of models in which interventions were restricted to those with high risk of malnutrition, only an additional 15% of all the malnourished patients were treated in the proposed pathway compared to the current pathway. In the second series of models in which interventions included individuals

with both medium and high risk of malnutrition, an additional 35% of all malnourished subjects were treated.

4. Nutritional support in some groups may bring little if any immediate net cost benefit, but it may produce longer term effects that ultimately reduce the prevalence of malnutrition and its cost, through reduced hospital admissions, reduced dependency and reduced use of other healthcare resources. Despite their importance, the models used in the current analyses were not designed to examine long-term effects, including those due to implementation of preventive measures. Workers in the Netherlands have reported that multiple nutritional interventions in multiple settings between 2004 and 2012 were associated with extraordinarily large long-term reductions in the prevalence of malnutrition: about 30% in hospitals, about 35% in home care and almost 50% in care homes[74]. In the face of a growing aging population, with a higher prevalence of malnutrition than in younger populations, it is necessary to make long-term investments to combat the burden of malnutrition. These investments should not only aim to prevent and treat malnutrition at an early stage, but also to establish one system of coordinated care across care settings. New costing models to evaluate the potential long-term investments in such schemes need to be developed.

Part C

Appendix

Assumptions about annual activities in hospital and community settings

All the activities indicated in this section refer to annual activities. Within each setting, the total number of subjects involved in the current and proposed pathways is the same, although the proportion being screened, assessed, and treated using appropriate nutritional support differs.

1. Activity: admissions, and GP/outpatient clinic attendances

Table C.1 summarises the total activity and proportion due to malnutrition in various care settings. The data are applied to both the current and proposed pathways of care.

Table C.1 Total annual activity in hospital and community settings and activity involving malnourished subjects

	Hospital inpatient admissions	Hospital outpatient (first attendances)	General practice (new registrations)	Care homes/own homes
Number of subjects	8,756,436	10,396,158	4,097,864	120,000
% malnourished	28.3	15.0	7.5	35
Number malnourished	2,478,071	1,559,424	307,340	42,000

The prevalence of malnutrition in the various settings is based on studies summarised in the section on 'Epidemiology of malnutrition'. The numbers of hospital inpatient admissions, new attendances at outpatient clinics and new registrations at GP practices were based on the information detailed below, much of which originated from the Information Centre.

Hospital inpatients

The total number of adult elective and non-elective inpatient admissions (including those admitted from waiting lists) in 2011–12 was 10,945,545 (data from Information Centre provided to M. Elia following a specific request). The data obtained from the Nutrition Screening Week surveys also involved elective and non-elective admissions, including waiting list admissions. Since the NICE guidelines considered an opt out option for certain populations in which malnutrition is less relevant, in the present analysis it was assumed than 20% of all admissions (excluding obstetric and 'midwife episode' admissions) could opt out, but a sensitivity analysis was undertaken to examine the effect of varying the proportion by ±20% of the base case value. Given that the Information Centre (data based on PbR) indicated that in 2011–12 there were 10,945,545 elective and non-elective adult admissions (≥18 years); 80% of this corresponds to 8,756,436 admissions ± 20% of this value established the range of 7,005,149 – 10,507,723 admissions, which was used in the sensitivity analysis.

The present model differed from that used by NICE in a number of ways:

1. The current costing model included only adults because the NICE guidelines only apply to adults. The NICE model included children >14 years.
2. The current analysis was based on hospital episode statistics for 2011–12 whereas the 2012 NICE costing report[12] was based on 2010–11 data, and the 2006 NICE costing report[14] on earlier data.
3. There was less blanket exclusion in the current costing model than in the NICE model. For example, the current model included waiting list admissions (with the exception of maternity) but the NICE model excluded all such admissions. These waiting list admissions accounted for more than one-third of all admissions in 2010–11. In addition, the NICE costing model excluded 80% of admissions associated with some groups of patients, such as those involving gastroenterology, cardiology and thoracic medicine, as well as cardiothoracic

surgery and neurosurgery (blanket exclusions). It also excluded other groups, such as those managed by ophthalmology, ear nose and throat (ENT) and genitourinary medicine services as part of the 'opt out group' mentioned in the NICE guidelines/quality standard. Furthermore, it excluded adult patients with mental illness (another component of the opt-out group), although they accounted for only about 1% of all admissions. Some of the exclusion criteria used by NICE may have been chosen to avoid double counting. In the current model it was assumed that in practice a certain amount of double counting was inevitable, and that policies to select and screen only some individuals within a given diagnostic category would be complicated and impractical, especially since the results of screening undertaken in one setting are inconsistently communicated to another setting. In addition, any double counting associated with new GP registrations would represent only a small proportion of hospital admissions. This is because the number of new GP registrations in a year was taken to represent only 10% of the adult population, whereas the number of hospital admissions was not restricted to such a small population. In the present model an the opt-out option was used, which involved excluding 20% of adult admissions after obstetric and 'midwife episode' admissions had been removed. The sensitivity analysis involved varying the remaining 80% of admissions by ±20% of this value (i.e. 64–96%).

4. In the present report the overall prevalence of malnutrition in adults on admission to hospital was taken to be 28.3% (33.6% in older adults and 25.1% in younger adults; see Part A: Epidemiology of malnutrition). This is a little lower than that reported by the Nutrition Screening Week surveys (29.6%) and also NICE (rounded to 30%) because in the present work the Nutrition Screening Week results were adjusted for the case mix in age (admission rate within each decade of adult life), type of admission (elective and non-elective) to conform with the data provided by the Information Centre.

Hospital outpatients

The number of new adult outpatient attendances (≥18 years (excluding obstetric and maternity attendances) was 12,995,198 for the year 2011–12, according to data provided by the Information Centre. With 20% blanket exclusion due to the opt out option, as for the inpatient population, the figure becomes 10,396,158.

The prevalence of malnutrition was assumed to be 15%, on the basis of studies described in Part A of this report (Epidemiology of malnutrition), which is consistent with the assumptions used in the NICE reports (15%[14] and 16%[12]). The sensitivity analyses involved varying both the prevalence of malnutrition (between 10% and 20%, i.e. by ±33% of the baseline value) and the outpatient activity (from -20% to 0% of the baseline activity (8,316, 926 to 12,475,390).

General practice

As in the NICE model, it was assumed that the annual number of new GP registrations was equal to 10% of the registered population. In 2011 the number of GP registrations was 52,010,272[75] (equivalent to 98.3% of the total population of England[76], of which 40,978,640 were adults (≥18 years)). Since the present analysis addresses only adult malnutrition, the costing template was based on 10% of the adult population (4,097,864), rather than 10% of the entire registered population of adults and children in England, which was used in the 2012 NICE costing report (5,157,31, corresponding to 2009 mid-year registrations). (In the 2006 NICE report the calculations were also based on '10% of all patients registered with a GP in England' but the figure used (4,520,175) was less than 10% of the entire registered population of adults and children in England and more than 10% of the adult registered population, both for the years before and after publication of the 2006 report.)

From the population census (2011) it can be calculated that about 0.7 million 17-year-old children become 18-year-old adults each year, and this could be considered to represent approximately 0.7 million new adult registrations. A further 0.7 million people registered in another local authority (flag 4 registrations). However, the majority of new registrations probably arose from a change in GP within the same local authority/council, perhaps even within the same practice, with an additional contribution from immigrants.

There is little information about the prevalence of malnutrition among people attending general practices and no specific information for those newly registered with a GP. A recent report indicated that the prevalence of malnutrition (medium + high risk, according to 'MUST') was 11% among adults attending consecutive weekday appointments at general practices located in areas with more than average deprivation[35]. However, the prevalence may be lower in areas with less deprivation. For the base case analysis of this report the prevalence of malnutrition in adults was taken to be 7.5% (compared to 5% in the NICE reports), with a range of 4–11% in the sensitivity analysis. New registrations were assumed to account for 10% of all registrations in the base case analysis, but a range of the 8–12% was used in the sensitivity analyses (corresponding to ±20% of the baseline value i.e. 3,278,291 minus 917,437).

Care homes

In the present analysis the number of admissions to care homes was based only on the permanent and short-term (non-respite) admissions (see Glossary for definition of 'Admission permanent', 'Admission temporary' and 'Admission short-term'). Temporary admissions and transfer of patients between residential and nursing homes were not included.

According to the Information Centre, the number of permanent adult admissions (aged ≥18 years) supported by local authorities during 2011/02 (1 April 2011 to 31 March 2012) was 67,745[77], corresponding to 30.2% of the resident population on 31 March 2012. This figure includes service users whose funding was transferred from the NHS to councils. The corresponding number of short-term (non-respite) admissions could not be identified from social care reports or from online information and therefore it was estimated using two sets of data (the period prevalence and the point prevalence) and two assumptions, which will be described shortly. The period prevalence represents the number of residents who received short-term residential (non-respite) care during the year (69,100 in the final report; 69,690 in a provisional analysis). This number was taken to include residents already in care homes at the start of the year (previous admissions). The point prevalence represents the number of people resident in the care home at the end of the period (15,010 on 31 March 2012, or 6.7% of the total number (224,450) of local authority supported residents). The first of the two assumptions is that there was a steady state in the proportion of all adult residents receiving short-term (non-respite) care, so that this proportion was the same at the beginning and end of the year. The second assumption is that none of the short-term residents already in place at the beginning of the year were still there at the end of the year. On the basis of these assumptions, the number of new admissions during the year was calculated as the difference between period prevalence and the point prevalence (69,100 – 15,010 = 54,090). During the same year there was also a transfer of 6130 permanent admissions between nursing and residential care, which were not included in the analysis because such transfers frequently occur within the same care homes which provide both nursing and non-nursing care. Therefore, the total number of permanent (67,100) and short-term (54,090) adult admissions during the year was estimated to be 121,190 or approximately 120,000, the figure used in the base case analysis (c.f. 126,267 reported in the first NICE costing report, and no mention of a change to this figure in the second costing report). In the sensitivity analysis variations of ±20% were used (96,000 – 144,000).

The prevalence of malnutrition was taken to be 35% (see Epidemiology of malnutrition in Part 1 of this report), the same as that used in the 2012 NICE report (both based on prevalence data provided by Russell and Elia following analysis of the Nutrition Screening Week surveys), but considerably higher than the prevalence of 21% used in the 2006 NICE costing report.

2. Activity: screening

The proportions of subjects screened in different settings in the current and proposed pathways (Table C.2) were the same as those used in the NICE model, as expert opinion considered these to be appropriate for the practice in 2011–12. For many providers it is unlikely that 100% screening would be achieved, and so 90% screening was retained. No data on NHS screening activity in care homes are indicated in Table C.2 because such activity is generally funded by the social care services, mainly local authorities. Only direct costs incurred on the NHS are considered in this report, in line with the approach used by NICE. In addition, the Nutrition Screening Week surveys suggested that nutritional status is routinely assessed in almost all care homes.

3. Activity: assessment

Table C.3 shows the activity involving assessment in different settings. On the basis of expert opinion, the proportion of malnourished individuals referred for nutritional assessment in different settings was kept the same as in the NICE model, with the exception of new outpatient attendances where the proportions involved in the current and proposed pathways (10% and 18%, respectively) were increased (to 25% and 33.33%, respectively, to meet the specifications of the basic model; see An overview of the costing model).

4. Activity: nutritional support (ONS, ETF, PN)

The activities associated with the use of ONS, ETF and PN in the proposed pathway were higher than those in the current pathway to the extent shown in Table C.4 and C.5.

ONS activity

Nutrition Screening Week data[25] suggested that over 72% of malnourished patients admitted to hospital were at high risk of malnutrition, requiring treatment. This treatment may follow recommendations made by specialists, typically dietitians who assess patients, but it may also be initiated by other healthcare workers who often follow local policies with regard to the management of certain groups of patients. In the proposed pathway (Table C.4) 65% of patients with medium + high risk of malnutrition (equivalent to 90% of those at high risk) were assessed for nutritional support or given ONS according to local policies without prior dietetic assessment. In the current pathway only 45% of patients were referred for an assessment followed by treatment or given ONS days independently of dietetic assessment. Both groups received ONS for 7 days.

The proportions of malnourished subjects newly registering at GP clinics and newly admitted residents to care homes assigned to receive ONS in the proposed pathway was higher than in the NICE costing model. This change was made to meet the specifications of the model, which aimed to provide nutritional support to 80–90% of those at high risk of malnutrition (and in a second series of models, medium + high risk of malnutrition). Baseline values were modified according to expert opinion about current practice. The duration of ONS prescription in the community was reduced from 180 days to 90 days, also on the basis of expert opinion about typical current practice.

ETF activity

ETF activity in the proposed pathway was 16% higher than that of the current pathway in the hospital setting and 8% higher in the community setting. Although these increments are comparable to those used in the NICE reports (16.6% and 8%, respectively) there is no strong rationale for choosing them (see Introduction). They were regarded as starting points for the sensitivity analyses, which examined the effect of varying the values from 0 to 32%. The duration of ETF prescription in hospital (12 days) remained unchanged.

ETF activity in the community setting for England in 2011–12 was based on information from the British Artificial Nutrition Survey (BANS) (provided by Dr T. Smith). The estimated point prevalence of home ETF in adults in England was 25,000 which was used for the current pathway. This was increased to 27,000 (8%) in the proposed pathway. For comparison, the 2006 NICE report used a point prevalence of 22,011 for the current pathway, and the 2012 NICE report did not indicate any changes in the model. The total annual activity, expressed in subject-ETF days, was calculated by multiplying the point prevalence by 365.

PN activity

As for ETF, the activity of the proposed pathway for home PN (HPN) was set 16% higher than that for the current pathway in the hospital setting and 8% higher in the community setting. Also a for ETF, the values for the proposed pathways for PN were not considered to have a strong basis, and so the sensitivity analyses covered increments within the range of 0–16%. The duration of PN in the hospital setting was reduced from a mean of 16 days (which was used in the NICE reports) to 12 days (current report), so that it would be in line with the National Confidential Enquiry into Patient Outcomes and Death (NCEPOD) on the use of PN in hospital[78]. In the community, the point prevalence of adult HPN was taken to be 969 (compared to 694 in the 2006 NICE costing report and there was no indication to suggest that there had been a change in the 2012 report). According to BANS (data provided by Dr T. Smith) the recorded point prevalence of adult HPN in England in 2012 was 775, but since this was considered to represent only about 80% of patients on HPN in England, the total point prevalence was assumed to be 969 (775/0.8). As for home ETF, the activity associated with the proposed pathway was 8% higher than that of the current pathway (compared to 8.9% higher in the NICE report) and the annual HPN activity, expressed in subject-HPN days, was calculated by multiplying the point prevalence by 365.

5. Activity: training the healthcare workforce

Training and education of healthcare workers in line with the NICE guidelines/standard was considered to deliver a large cost impact through better recognition and treatment of malnutrition. However, NICE[14] considered this to be a non-recurrent expenditure with ongoing training being absorbed into the work of dietitians and specialist nutrition support nurses. This absorption could involve continuing professional development of staff.

However, the non-recurrent expenditure associated with training of the workforce can be estimated to be £2.2 million:

1. Using NHS workforce statistics for 2012 it can be estimated that there was a total of 346,410 qualified nurses and midwives, but after exclusion of health visitors and those involved in maternity, paediatric and neonatal services the figure becomes 284,128. The number of staff supporting doctors and nurses (e.g. healthcare assistants) was reported to be 269,714, but after exclusion of nursery nurses, clerical/administrative staff and those in Estates (maintenance works) the figure becomes 126,515. Therefore the total relevant workforce requiring education and training can be estimated to be 410,643 (284,128 + 126,515).

2. Although there are various ways in which education and training in the identification of malnourished inpatients for nutritional support can be implemented the commonest method involves a lecture and workshop[25]. If this is delivered to groups of 15 members of staff over a 3-hour period by mid-grade 6 dietitians or specialist nutrition support nurses (£27/hour, based on the 2012 Agenda for Change) this is equivalent to 27,762 training sessions at £81/session. The total non-recurrent expenditure is £2,248,722 (27,762 x £81) or approximately £2.2 million.

In reality much of the workforce is already receiving some training to identify patients with malnutrition[25] using 'MUST' criteria, so that those with malnutrition can be managed appropriately. Furthermore, separate, interactive e-Learning modules for using the 'MUST' framework in hospital, community and care home settings have been developed by BAPEN, and recommended by Quality Improvement and Innovation (QIIP, NHS England) and NICE. The modules have become mandatory training for all nurses in some trusts or healthcare regions because they are considered to be a very cost-effective method of training the workforce, especially if they complement other types of education and training.

The need to train other staff and health professionals allied to medicine who are involved in patient care is also recognised, but the cost is not included in the template, again because it was anticipated that it would be part of the general induction training, without increasing expenditure. Ongoing training and education for existing staff could be undertaken by specialist nutrition link nurses or dietitians.

6. Summary of annual activities of the current and proposed pathways

Table C.2 Screening activity: assumptions associated with current and proposed pathways

	Hospital inpatient admissions		Hospital outpatients (first attendance)		General practice (new registrations)		Care home/own home	
	Current pathway	Proposed pathway	Current Pathway	Proposed pathway	Current pathway	Proposed pathway	Current pathway	Proposed pathway
Total activity (from Table A.1)	8,756,436	8,756,436	10,396,158	10,396,158	4,097,864	4,097,864	Not NHS	Not NHS
% screened	65	90	15	.90	10	90	Not NHS	Not NHS
Number screened	5,691,683	7,880,782	1,559,424	9,356,542	409,786	3,688,078	Not NHS	Not NHS

Table C.3 Nutritional assessment activity: assumptions associated with current and proposed pathways

	Hospital inpatient admissions		Hospital outpatients (first attendance)		General practice (new registrations)		Care home/own home	
	Current pathway	Proposed pathway	Current pathway	Proposed pathway	Current pathway	Proposed pathway	Current pathway	Proposed pathway
Number malnourished (from Table A.1)	2,478,071	2,478,071	1,559,424	1,559,424	307,340	307,340	42,000	42,000
% assessed	30	40	15	20	10	0.1667	10	16.667
Number assessed	743,421	991,229	233,914	311,885	30,734	51,223	4,200	7,000

Table C.4 Treatment: assumptions associated with ONS activity (number of subject days ONS) in various settings

	Hospital inpatient admissions		Hospital outpatients (first attendance)		General practice (new registrations)		Care home/own home	
	Current pathway	Proposed pathway	Current pathway	Proposed pathway	Current pathway	Proposed pathway	Current pathway	Proposed pathway
Number assessed (from Table A.3)	743,421	991,229	233,914	311,885	30,734	51,223	4,200	7,000
% assessed given ONS	65	65	0.65	0.65	50	50	50	50
Number assessed given ONS (a)	483,224	644,299	152,044	202725	15,367	25,612	2,100	3,500
Number malnourished (from Table A.1)	2,478,071	2,478,071	1,559,424	1,559,424	307,340	307,340	42,000	42,000
% of all malnourished given ONS (without being assessed)	15	20	7.5	10	10	16.667	25	41.667
Number of malnourished given ONS (without being assessed) (b)	371,711	495,614	116,957	155,942	30,734	51,223	10,500	17,500
Total number given ONS ((a) + (b))	854,935	1,139,913	269,001	358,667	46,101	76,835	12,600	21,000
Duration of ONS	7	7	7	7	90	90	90	90
Total activity (subject-days ONS)	5,984,542	7,979,390	1,883,004	2,510,672	4,149,087	6,915,145	1,134,000	1,890,000

Table C.5 Treatment: assumptions and calculation of ETF activity (subject-days ETF) and PN activity (subject-days PN) in hospital and community settings

	Hospital inpatients		Community	
	Current pathway	Proposed pathway	Current pathway	Proposed pathway
Enteral tube feeding (ETF)				
Number malnourished (see Table C.3)	2,478,071	2,478,071		
% given ETF	6	6.96		
Number given ETF	148,684	172,474	25,000†	27,000†
Duration of ETF (days)	12	12	365	365
Activity (subject-ONS days)	1,784,211	2,069,685	9,125,000	9,855,000
Parenteral nutrition (PN)				
Number malnourished (see Table C.3)	2,478,071	2,478,071		
% given PN	3	3.48		
Number given PN	74,342	86,237	969†	1,047†
Duration of PN (days)	12	12	365	365
Activity (subject-PN days)	892,106	1,034,843	353,685	382,155

† values represent the estimated point prevalence

Assumptions about unit cost

1. Unit costs: screening

The unit costs for screening were calculated assuming that screening takes 5 minutes[69] using salary scales provided by the Agenda for Change Agreement beginning in April 2012[65], after allowing for overheads. Since the salaries of staff undertaking screening in various care settings were not the same, the unit costs for screening varied according to care setting (Table C.6). In the sensitivity analysis the time taken to screen was varied by ±4 minutes (i.e. between 1 and 9 minutes) and the pay scale by ±1 band. The variation in the time taken to screen was based on expert opinion and data from the literature, which suggested that screening could be performed as quickly as 1 minute using an electronic system[29] or <2 minutes using standard procedures[66].

Table C.6 Unit cost of nutritional screening in various settings

	Hospital inpatients	Hospital outpatients	GP surgery
Grade of staff (Agenda for change)	Top of band 4 (ward nurse)	Mid-point of band 3 (healthcare assistant)	Mid-point of band 5 (community nurse)
Annual salary*	£31,498	£25,458	£34,783
Working weeks × hours per week	42 × 37.5 = 1575 h	44 × 37.5 = 1650 h	42 × 37.5 = 1575 h
Hourly rate	£20.00	£15.43	£22.08
Number of minutes for screening	5 min	5 min	5 min
Unit cost for screening (cost/screen)	£1.67	£1.29	£1.84

*Includes employer cost (̴24.5% of salary) and 20% uplift of salary for overheads and staff training

2. Unit cost: assessment

The unit cost for assessment was calculated to be £16.45 in all care settings (Table C.7), based on the salary scale of a band 5 dietitian. Although practice varies in different parts of England, expert opinion considered this band to be appropriate for 2011–12 (compared to the NICE reports in which the unit cost was based on a salary of a dietitian at the top of the band 6 salary scale (with ~43% higher salary). In the sensitivity analysis the time taken to assess was varied by ±15 minutes and the pay scale by ±1 band.

Table C.7 Unit cost of assessment in all settings

	Dietitian assessment
Grade of staff (Agenda for Change)	Mid-point of band 5
Annual salary*	£35,649
Working weeks × hours per week	42.76 × 37.5 = 1603.5 h
Hourly rate	£22.23
Number of hours for 'assessment†'	0.75 h
Unit cost for assessment (cost/assessment)	£16.45

* Includes employer costs and staff overheads (~47.35% of basic salary)
† includes the cost of any follow-up that might take place

3. Unit cost: nutritional support

In an attempt to establish consistency in the unit costs for various types of treatment, two general principles were followed. First, only the costs to the NHS were considered, in line with the approach used by NICE. Second, if a treatment requires additional resources, such as additional work by nurses or other health workers, the cost of these additional resources are taken into account, unless they replaced an equal amount of work by the same type of healthcare worker, in which case they are not taken into account.

Some of the unit healthcare costs are approximate, since both clinical practice and the operational infrastructure for providing nutritional support vary across the country. In addition, the boundary between healthcare and social care is not always clear[79]. For example, social care may provide and/or purchase care from allied health professionals, including dietitians/nutritionists working in public or private healthcare organisations. Furthermore, individual trusts may deal with both health and social care, and some of the funding initially allocated to the NHS centrally is taken out entirely and moved into the social care budget (~£0.7 billion in 2011/12)[80]. The complexity of the situation increases further when healthcare trusts contract nutritional support for home ETF and PN from home care companies (the usual procedure), which provide nursing support and deliver feeds and ancillary equipment to the patient's home. This avoids the need for trusts or the NHS to set up services that would be expensive if they had to cater for only a small number of patients distributed over a wide geographic area. Commercial home care companies may also undertake training of patients and/or carers before hospital discharge, although hospital nurses and dietitians often initiate this training before discharge, blurring the boundaries between primary and secondary care budgets.

A summary of the costs of treatment (cost per day) is provided in Table C.8. The basis of these unit costs is indicated in the section immediately below the Table.

Table C.8 Unit costs (cost/day) associated with treatment of ONS, ETF and PN

	Hospital inpatient	Hospital outpatients	Community (new GP registrations)	Community (care home and own home)
Treatment*: ONS	£0.04	£0.04	£3.70	£3.70
ETF†	£11.01			£10.15
PN†	£55.90			£141.20

ONS = oral nutrition supplements; ETF = enteral tube feeding; PN = parenteral nutrition
*Unit costs are expressed in £/day/patient
† The unit costs do not take into account the cost of education training provided by hospital nurses and dietitians to a small proportion of patients (and/or their carers) who continue to receive ETF and PN in the community after discharge from hospital. If 1% of patients starting PN in hospital continue to receive PN in the community, the extra cost of training and education, assuming this involves several hours of nursing/dietetic time, would be considerably less than 1% of the unit cost. If 5% of patients given ETF in hospital continue to receive it in their own homes (excluding another 5% assumed to be discharged to nursing homes where nurses are already trained to administer ETF) the extra cost of education and training involving 3.5 hours of nursing/dietetic time (mid-point of band 5) this would be about 5% of the unit cost in hospital (and <5% if commercial home care companies are involved in training and education before and after discharge from hospital. The figures for the proportion of patients starting PN (i.e. those needed to establish the approximate point prevalence indicated in this report) were calculated assuming that the ratio of home ETF (HETF) patients starting HETF during a year to number of HETF patients receiving HETF at a given point in time was 0.638. The corresponding ratio for HPN was assumed to be 0.474[81]

ONS

Hospital inpatients and outpatients

Due to changes in contractual arrangements for purchasing ONS in hospitals, the daily cost of ONS in 2011–12 was only £0.01– £0.04. A value of £0.04 is used in the present report, which is considerably lower than the 2005–06 price of about £0.50–£0.70 per day. This explains why a unit cost of £0.60/day was used in the 2006 NICE report (for the 2012 report, this value was uplifted to £0.74/day to take into account inflation).

Community (GP surgery and care homes)

During 2011/12**,** the use of ONS in the community (standard sip feeds providing about 600 kcal per day) was estimated to cost the NHS £3.70 per patient per day. It was assumed that the supplements would be obtained at the local pharmacy by the patient or carer without incurring delivery costs to the NHS. This value of £3.70 per day is lower than that in the 2006 NICE report (£5.12) and 2012 NICE report (£6.28), the latter having been established by inflating the 2006 unit cost.

Non-ONS oral nutrition support

Hospital inpatients

According to NHS Estates (England) the cost of hospital food in 2011–12 was £8.77 per patient per day[82], but the cost of the food itself was probably only about £3 per day, the remainder being due to staff and other associated costs, most of which also apply to non-malnourished patients. Many malnourished patients in hospital eat little and sometimes not at all on account of their condition. This may reduce the costs of oral food and counteract the cost of any extra food fortification with butter, cream or milk powder, or snacks, which may be given to compensate the lack of nutritional intake. Although the model assumed that no extra costs were associated with oral non-ONS nutritional support, sensitivity analysis examined this assumption further (±50% of the estimated cost of the food itself). The NICE costing model did not take into account modified food menus and food fortification because they were considered to be within the normal dietary provision, and therefore perceived not to have a significant cost impact in relation to the NICE clinical guideline (CG 32). No modifications were reported for the costing model associated with the NICE quality standard (QS24).

Community

In care homes, where the number of patients receiving such support in a year was only 1–2% of the number of hospital inpatients, the costs were assumed to be absorbed by the social care services; and in the community it was assumed that they were largely absorbed by the patients themselves (e.g. snacks between meals). Therefore, these interventions were assumed to incur no extra costs to the NHS.

ETF

Hospital

Due to changes in contractual arrangements in hospitals, the combined cost of tube feeds and giving sets necessary for ETF in hospital was only about £0.04 per day in 2011–12. However, because of the need for additional costs associated with certain routines, including nasogastric tube insertion, which in some cases requires X-ray confirmation of the position of the feeding tube, the unit cost is much higher. It was assumed to be £11.01 to take into account the following: £3.38 for the cost of the nasogastric tube multiplied by a factor of ×1.2 (i.e. £4.06) to allow for reinsertion of tube in 20% of patients (equivalent to £0.34 per day over a 12-day period); £10.00 per day for 0.5 hours of nursing time (band 4) (see below); and a further £7.50 for placement and confirmation of tube position by X-ray in 25% of patients (for a 12-day period of feeding this is equivalent to an additional £0.63/day). The overall daily cost (£0.04 + £0.34 + £10.00 + £0.63 = £11.01) is higher than that used in the 2006 NICE report (£5.87 per day) and the 2012 NICE report (£7.19 per day). The largest cost is that of additional nursing time, which includes the time taken to intermittently aspirate stomach contents to check for gastric residuals, crushing tablets to administer certain types of medication though the tubes, changing of feeds, and responding to any alarms arising from the pumps used to administer the feed. In the models that included hospital ETF and PN (see next section) it was assumed that the cost of the extra activity needed for the implementation of the proposed pathway replaced the cost of some other activities (e.g. problems with the development of malnutrition), producing a cost neutral result (see also discussion on hospital PN in the section that follows and item 4 in the Introduction to Part B of this report).

Community

The cost of enteral tube feeding in the community not only took into account the cost of the feed and giving set (£7.10 per day, based on various sources of information including information from industry), but the model includes the cost of maintaining the gastrostomy feeding tube, including its (re)insertion, which for many patients occurs three times per year (equivalent to £0.55 per day during the entire year) and delivery of feed to many of the patients' homes. Assuming these are met by the NHS (in reality these are met by home enteral tube feeding companies), the overall cost is estimated to increase the total cost to £10.15 per day. No extra costs for human resources were added since ETF in the patients' own home is typically managed either by the patient or informal carers or home care services from industry rather than workers employed by the NHS. In nursing homes, no extra NHS costs for human resources were included because they were typically met by the social care services. The daily rate for ETF used in this report (£10.15) is less than that stated in the 2006 NICE report (£12.39) and in the 2012 report (£15.19). The costs are consistent with those associated with commercial home care companies. It was assumed that the costs for patients not using home care companies (but involving input from nurses, dietitians and other healthcare workers) are the same.

PN

Hospital

The cost of feeding using a standard feed and administration set was estimated to be £50 per day, as in the 2012 NICE report. However the NCPOD report[78] indicated that 21.8% of PN involved bespoke PN bags, which are estimated to cost about £100 per day, making the weighted average cost £55.90 per day. No additional costs for human resources were included for administering PN because these were considered to replace the cost of other activities. For example, if patients had not been started on PN they probably would have had other needs that would impose a burden on staff, such as the administration of intravenous fluids, often from several bags each day, and recording and collection of gastrointestinal effluents, probably in higher quantities if the patients were allowed to eat. Taken together, these issues suggest that withholding PN in such patients may require just as much if not more attention and staff time than administering it.

Community

As for ETF, different contractual arrangements exist for PN in hospital and community settings. Using 2011–12 prices it is estimated that the cost of the PN admixture, giving set and delivery of feed to a patient at home was £95 per day, although it is recognised that this varies according to the patient's needs and the local contractual arrangements, which can vary substantially in different geographical areas. In the calculation of the unit cost it was also assumed that nursing care would be required by one-third of the patients at a commercial rate of £140 per patient per day or £46.2 per patient per day if the cost is distributed over the entire HPN population. This makes the total average cost of HPN £141.2 per patient per day. This is substantially higher than the value of £95 used in the 2012 NICE report, because the former took into account the necessary extra cost for the nursing support provided by commercial companies, and the latter did not. The overall costs are consistent with those involving commercial home care companies. For the minority of patients who are not linked to home care companies the same costs were assumed to apply.

Calculating potential cost savings

Potential cost savings could occur through reduced hospitalisation (number of admissions and shorter length of hospital stay) and reduced outpatient attendances and GP visits. Each of these is considered in turn below.

1. Hospital inpatients: the effect of ONS in malnourished

In the base case analysis it was assumed that ONS reduced length of hospital stay by 13.9%, on the basis of the information provided below.

Background

In the absence of clear and robust evidence-based information on the cost savings resulting from reduced length of hospital stay following administration of ONS to malnourished patients, a new systematic review and meta-analysis was undertaken, and considered in the light of data already provided in the NICE costing reports. These NICE reports assumed that ONS reduced length of hospital stay by a mean of 1.4 days, but the source of this information is not entirely clear. Reference was made to the BAPEN report by Elia et al[83], but it is difficult to identify the studies that were used to establish this figure. Furthermore, many of the studies cited in the BAPEN report involved groups of subjects that included both malnourished and non-malnourished subjects with a mean age ranging from below 65 years to well over 65 years depending on the study. The original studies cited in the BAPEN report were published during a period spanning about two decades, during which there was a considerable reduction in length of hospital stay in both England and many other countries. NICE also reported, in a supplementary text to the Clinical Guideline document, the results of a random effects meta-analysis of six randomised controlled trials of older subjects (mean age in each study ≥65 years) who were considered to be 'malnourished'. The mean reduction in the length of hospital stay favoured the ONS group by 5 days, but this information does not appear to have been used in the NICE costing model. Furthermore, it would have been inappropriate to do so for several reasons. First, the studies, like others reported above, were undertaken over a period of about 20 years, during which the duration of hospitalisation has progressively decreased. There is also uncertainty whether the malnourished study populations are representative of those routinely admitted to hospital in current practice. Furthermore, since the analysis involved only older subjects (mean age >65 years), who are known to have a longer length of stay than younger subjects, incorporation of the data into a model involving adults of all ages could result in a potential bias. In view of these problems and uncertainties, a new systematic review with meta-analysis was undertaken, which included studies involving both younger and older age groups, and an analysis involving percentage reduction in length of stay rather than absolute reduction in days.

The meta-analysis

A literature search was undertaken on 12 April 2013, using MEDLINE and the Cochrane Library databases, followed by a meta-analysis involving 12 studies which aimed to examine the effect of ONS in malnourished hospitalised patients on length of hospital stay. This search identified another six studies in addition to those used in the meta-analysis by NICE (reported in five papers[84-88]). Only randomised controlled trials were considered. The ONS inclusion and exclusion criteria were based on those reported in the NICE Clinical Guideline 32. This meant that standard ONS were included in the analyses while disease-specific ONS, such as immune nutrition feeds containing large amounts of arginine and/or other nutrients, were not. Studies comparing one ONS with another ONS were also excluded. In addition, only study populations considered to be 'malnourished' by the authors of the papers (and/or NICE) were included. For example, Potter et al[86] classified patients with a BMI between 5th and <25th centile as mildly undernourished and those <5th centile as severely undernourished. Both groups were included in the meta-analysis.

The six additional studies included in the present analysis involved patients who were identified as malnourished[89, 90] according to anthropometric criteria[89] or the Nutritional Risk Index [90] or at risk of malnutrition[91] according to the Mini Nutritional Assessment. One study involved subjects who were predominantly malnourished according to the Mini Nutritional Assessment[92], and two others according to a BMI <25th centile[93, 94] or <25th centile for arm circumference[95]. All the studies provided data on the mean ±sd for length of hospital stay in the control and intervention groups.

Of the 12 comparisons of ONS versus no ONS, five involved patients with fractured femur, [84, 88, 92-95] one involved patients with stroke[85], and another four involved geriatric patients [86, 91] (one with two groups examined separately) or those with medical problems[87]. The remaining two studies involved patients undergoing abdominal surgery[89, 90], one of which included a small proportion of patients undergoing vascular surgery[89]. Three studies involved subjects with a mean age <65 years[87, 89, 90] and the remaining studies involved subjects with a mean age >65 years. Six studies were undertaken in the UK,[85-87, 89, 93, 94] two in Sweden,[88, 92] one in Australia,[95] one in Italy[91] and one in India[90]. All studies were published between 1990 and 2007, and involved a total of 1327 patients, 672 of whom were randomised to the ONS group and 655 to the control group. In one of the studies in which the number of subjects in each groups was not stated[90], it was assumed that there was an equal number in each group since the groups were established by randomisation of a known number of subjects.

The meta-analysis involved a random effects model, because of the clinical heterogeneity of studies, which was also suggested by the heterogeneity statistic (I^2 = 72%) (see Glossary). The mean length of stay of the ONS group was shorter than that of the control group by a mean of 3.391 days (se 1.566; P = 0.030). Since the mean length of stay in the control group was variable, ranging from 10–48 days (mean 25.252 days; se 2.726 days) established using a single sample random effects meta-analysis), the values within individual studies were expressed a percentage of the control group. A two-group meta-analysis of the transformed results also yielded a significantly reduced length of stay in favour of the ONS group by a mean 13.883% (se 6.559%; P = 0.034) of that of the control group (Figure C.1).

Study name	Condition	Statistics for each study		
		Difference in means	Standard error	p-Value
Delmi et al 1990	Fracture femur	-40.000	12.157	0.001
Gariballa et al 1998	Stroke	-42.857	12.982	0.001
Potter et al 2001 moderate underwt.	General geriatric	12.121	16.888	0.473
Potter et al 2001 severe underwt.	General geriatric	-2.857	26.839	0.915
Vlaming et al 2001	General medical	24.561	15.800	0.120
Tidermark et al 2004	Fracture femur	-25.926	20.194	0.199
Beattie et al 2000	Abdominal surgery	-10.680	12.209	0.382
Saluja et al 2002	Abdominal surgery	-0.971	0.933	0.298
Olofsson 2007	Fracture femur	-31.156	12.450	0.012
Gazzotti et al 2003	General geriatric	7.071	14.582	0.628
Brown & Seabrook 1992	Fracture femur	-43.750	17.855	0.014
Hankin 1996	Fracture femur	-7.692	23.751	0.746
		-13.883	6.559	0.034

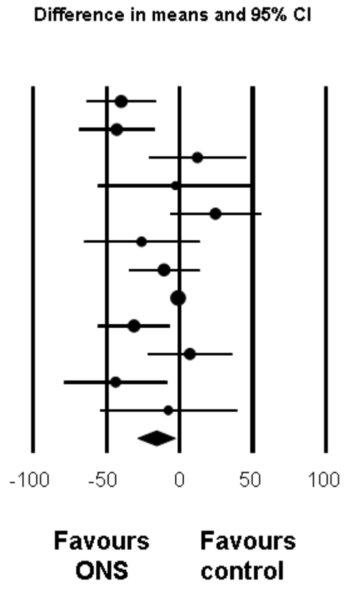


Figure C.1 Meta-analysis of length of stay with data with data within each study expressed as a percentage of the control group. A negative sign indicates a reduction in length of stay.

The Begg and Mazumbar test (P = 0.732) and Egger's test (P = 0.093) did not suggest publication bias.

For the base case analysis it was assumed that ONS reduced the mean length of hospital stay of malnourished patients by a mean of 13.9%.

2. Hospital outpatient attendances, hospital admissions and GP visits: effect of malnutrition and treatment with ONS

Observational data

Table C.9 compares healthcare utilisation of well nourished (low risk of malnutrition) and malnourished individuals (medium + high risk of malnutrition). The data are based on a secondary analysis of the National Diet and Nutrition Survey (NDNS) of people aged 65 years and over undertaken by Elia et al[83]. The results in Table C.9 are reproduced from a BAPEN report[83], with the exception of the last column which has been added to facilitate further relevant calculations. The NICE costing model used data on older people from the BAPEN report and extrapolated them to the entire population of malnourished people including those <65 years. The model also assumed that a fixed proportion of patients treated with ONS outside hospital would no longer be malnourished so that the difference in healthcare use between malnourished and non-malnourished patients could be used to calculate the cost savings due to ONS.

Table C.9 The number of visits and hospital admissions per older person (≥65years) per year and the ratio of these in malnourished to all subjects

Resource use*	Admissions or visits: Low risk of malnutrition	Admissions or visits: Medium + high risk of malnutrition	Admissions or visits: Medium + high risk minus low risk malnutrition	Ratio of admissions or visits: malnourished/non-malnourished (r)	Ratio of admissions or visits: malnourished /all subjects (R)
GP visits	4.307	7.097	2.789	1.648	1.571
Hospital outpatient visits	1.019	1.355	0.336	1.330	1.267
Hospital admissions	0.276	0.503	0.227	1.822	1.478

† based on Elia et al[83]

$R = \frac{r}{1-p+rp}$ where r is the ratio of healthcare use in malnourished to non-malnourished patients and p is the proportion of malnourished subjects in the entire population of subjects (malnourished + non-malnourished)
*Analysis of the original data indicated significant differences between malnourished and non-malnourished subjects for hospital admissions and GP visits, but not outpatient visits

However, potential uncertainties can arise when observational data are used to estimate the effects of interventions, and when it is assumed that the absolute reduction in healthcare utilisation in older people is the same as in younger adults or a mixture of younger and older people.

In an attempt to reduce the risk of potential bias, the following steps were undertaken:

(i) Results from interventional studies (rather than observational studies) were used whenever possible, especially those from systematic reviews with meta-analyses of randomised controlled trials.

(ii) Results expressed as a percentage reduction in healthcare utilisation were used in preference to the absolute reduction. This principle was applied to the amalgamation of randomised controlled studies involving younger and older people who are known to have different healthcare needs and different rates of healthcare utilisation. This situation is analogous to the effect of malnutrition (medium + high risk by 'MUST') in prolonging length of hospital stay by about 30% in both older (≥65 years) and younger adults (<65 years)[26], despite the two-fold difference in absolute length of stay between the two age groups.

(iii) Checks were made to ensure that that the budget impact analysis was internally consistent, for example, by ensuring that the number of additional people gaining benefit from treatment for malnutrition did not exceed the number of extra people given treatment.

Table C.10 shows the estimated absolute and relative rates of healthcare use (GP visits, outpatient attendances and hospital inpatient admissions) in malnourished and non-malnourished subjects in 2011/12. The distribution of the resources between malnourished and non-malnourished subjects was calculated using the relative rates of healthcare use indicated on Table C.9. The extra resources used by a malnourished subject compared to a non-malnourished subject are shown in the last column of the table.

The data on health care utilisation reported in this section were based on observational data, which do not necessarily reflect to which changes induced by clinical interventions. The extent to which health care utilisation can be reduced by interventions, such as the administration of ONS is addressed in the next section.

Table C.10 Estimated annual healthcare use in malnourished (M) and non-malnourished (NM) adults in England for 2011/12

	Rate ratio: number per MN/number per NM patient†	Rate ratio: number per MN/number per M + NM	Rate in all subjects (M +NM)*: number/ year)	Rate in M: (number/ MN/year)	Rate in NM: number/ year)	Difference in rate (M-NM): number/ year
GP visits	1.648	1.571	6.5	10.2	6.2	4.0
Hospital outpatient visits	1.330	1.267	0.99	1.25	0.94	0.31
Hospital inpatient admissions as in Table C.9	1.822	1.478	0.263	0.39	0.21	0.18

†Based on data by Elia et al[83], which also formed the basis of the assumptions used in the NICE reports. The data originated from a secondary analysis of the National Diet and Nutrition Survey of older subjects only (≥65 years)
*The absolute rates in malnourished (M) + non-malnourished (NM) adults (≥18 years) were based on the following: GP consultation rates were based on Q research extrapolated to the year 2011/12; hospital admissions and outpatient attendance were based on data provided by the Information Centre for 2011/12 and population census for people aged 18 years and over for 2011 which agrees to within 1.7% of the population of subjects registered with a GP.
+ The ratios were calculated using the same prevalence of malnutrition as used elsewhere in this report (28.3% for hospital inpatients, 15% for outpatients and 7.5% for those involved with GP visits)

Interventional data

The base case analysis assumed that interventions with ONS reduced resource use to the extent shown in Table C.11 for reasons given below.

Table C.11 The assumed effect of administering ONS to malnourished adults in the community on resource use*

Type of activity	Reduction in resource use (number of visits, or admissions/ subject/year
GP visits	2.0
Hospital outpatient visits	0.155
Hospital inpatient admissions	0.11

*The values were calculated by multiplying the results shown last column of Table C.10 with the fraction reduced by administering ONS (see text for details)

A systematic review with meta-analysis found that the malnourished subjects given ONS in the community had significantly fewer admissions than malnourished subjects not given ONS (relative risk 0.698; 95% CI, 0.566, 0.861), corresponding to an odds ratio of 0.591 (95%CI, 0.434, 0.804))[56]. This 30% reduction (100 × (1.000-0.698) = 30.2%) in the admission rate of malnourished subjects corresponds to over 60% of the difference in admission rates between malnourished and non-malnourished subjects. However, the studies in the meta-analysis did not include malnourished subjects given ONS in care homes, who accounted for 24% of the extra patients given ONS in the proposed pathway operating outside hospital (compared to the current pathway of care).

There is a scarcity of studies examining the effect of ONS in care home residents on hospital admission rates. However, two multi-centre studies examined the rates of hospital admission before and after implementation of the ‘MUST’ framework in care homes, which included use of ONS in malnourished residents[96, 97]. One of these studies reported a reduction in the rate of admission by 31% and the other by 37%. Although these studies with ‘before and after’ designs have limitations, they suggest that the intervention can substantially reduce hospital admission rates. In the current model it was assumed that hospital admissions were reduced by 30%. This reduction in admission rate corresponds to 63% of the discrepancy between the well-nourished and malnourished subjects (Table C.10), and an absolute reduction of about 0.11 admissions per year. However, in view of the uncertainty about the extent to which the studies included in meta-analyses reflect the general population of malnourished subjects incorporated in the model, the values were varied by ±50% in the sensitivity analysis (i.e. 0.11 ± 0.055 admissions per person per year).

Observational data (see footnote to table C.9) indicate that subjects identified as being malnourished using 'MUST' have significantly fewer GP and hospital outpatient visits, although the difference was significant only for GP visits. There is a general lack of data examining the effects of community interventions on GP visits and hospital admissions, although one randomised controlled study of milk powder supplementation in patients with chronic obstructive airways disease in the community reported a significant reduction in number of GP visits (by more than 30%) and non-significant reduction in outpatient attendances[98].

The model used in this report assumed, as a first approximation, that interventions with ONS in malnourished subjects halved the difference in observed rates of GP visits and outpatient attendances observed between malnourished and non-malnourished subjects. This corresponds to a reduction of 2.0 GP visits per year, and 0.155 outpatient visits per year. The sensitivity analyses examined a wide range of variability to reflect the uncertainty (a reduction of 0–4 GP visits per year and 0.31 outpatient attendances per year).

The above methodology differs from that employed by NICE in at least three major ways:
(i) Reduced length of hospital stay (LOS): (a) the present analysis not only relied on the results of a new meta-analysis on the effect of interventions with standard ONS on length of hospital stay, but also in undertaking calculations using percentage reductions in length of stay, rather than absolute reductions in days. This change aimed to make the results more relevant to current practice, potentially reducing the variability arising from amalgamating data obtained over the last 20–30 years in studies in which the mean age of the populations varied from <65 years to ≥65 years; (b) in the present report, the cost of hospital inpatient admissions was calculated as the average of elective and non-elective admissions (based on data from the Information Centre), adjusted for the effect of malnutrition (30% longer length of stay than non-malnourished) while the calculations in the 2012 NICE report involved only those associated with elective admissions (total cost of elective admissions divided by the number of first consultant episodes). (ii) Reduced hospital admissions, GP visits and outpatient attendances: In the present report evidence-based information on interventions with ONS underpinned the calculations on rates of resource use. In the NICE reports, the calculations relied on observational data and an assumed reduction in healthcare use induced by ONS, which does not appear to have been evidence based. All reports considered observational data provided by Elia et al[83], which in turn were based on a secondary analysis of a National Diet and Nutrition Survey. (iii) The current report used updated data on activity and unit costs for the year 2011–12, many of which were obtained from the Information Centre using data based on HRG and PbR. Earlier datasets were used in the NICE reports.

3. Unit cost savings

The unit cost for hospital admissions, GP visits and outpatient attendances used in the budget impact analysis are shown in Table C.12.

Table C.12 Unit cost of GP visits, hospital outpatient attendances and inpatient admissions England 2011/12

Activity	Unit cost
GP visits*	£43.00
Hospital outpatient visits**	£130.15
Hospital inpatients admissions**	£1965

*based on Curtis
**calculated using data provided by the Information Centre (assuming that malnourished subjects have 30% longer hospital stay than non-malnourished subjects)

4. Assumptions in calculating the contribution of younger and older adults to the budget impact

The distribution of hospital admissions by age category (18–64 years and ≥65 years) was based on data from the Information Centre, and the age-specific prevalence of malnutrition on the Nutrition Screening Week surveys, as already described. The distribution of outpatient attendances by age was also based on information from the Information Centre. With respect to hospital PN it was assumed that 52% of the expenditure involved older people (from a graphical presentation of grouped age distribution in the NCPOD report[78]). This is consistent with a study of 197 consecutive patients in a general hospital in which older people accounted for 55% of the total number of PN-days. For hospital ETF it was assumed that 67% involved older subjects. In the community setting, it was assumed that 52% of adults (≥18 years) receiving HETF at a given point in time were older adults (based on calculations involving the point prevalence indicated in the 2010 BANS report[99]) and 23% of adults receiving home PN (based on the point prevalence indicated in the 2011 BANS report[81]).

The distribution of GP visits by newly registered patients was taken to be the same as that for all patients registered at general practices[20], 46% involving older adults (with an estimated prevalence of malnutrition of 10%) and 54% involving younger adults (with an estimated prevalence of malnutrition of 7%). Most adults admitted to care homes between 1 April 2011 and 31 March 2012 (90% of permanent admissions) were older people.

Hospital bed-day costs by age were obtained from the Information Centre. Unit costs for GP visits (new registrations only) and outpatient attendances were assumed to be the same in younger and older people. The daily costs of ONS, ETF and PN (already defined in this report) were taken to be the same in older and younger adults. It was also assumed that the percentage reduction in healthcare use resulting from the use of ONS was the same in older and younger subjects in hospital and community settings. For example, for hospital inpatients a cost saving of 13.9% of the cost of hospital admissions was also applied to both younger and older subjects but the age-specific absolute costs of hospitalisation were taken into account (with adjustments for prolongation of length of hospital stay (30%) due to malnutrition).

A series of sensitivity analyses were undertaken which included varying the contribution (proportion) of older people to the following: number of patient-PN days in hospital (37–67%) and patient-ETF days in hospital (52–83%); cost saving due to use of ONS in hospital (52–67%); and a variety of community activities.

Part D

Glossary of terms and abbreviations

Admission episodes (hospital): Count of episodes that were the first in the spell of admitted patient treatment. Day cases are included in the total number of admission episodes. Technically, the count includes patients admitted in the previous year (1 April) and who are inpatients in the current year.

Admission permanent (care home): Admission for residential or nursing care with no end-date specified. For those classified as permanent residents, the care home can be regarded as the normal place of residence.

Admission temporary (care home): Admission of a temporary nature and of limited duration (although in some cases it may be lengthy). It includes respite care, rehabilitation, short breaks and other care with the intention to be temporary irrespective of the actual duration.

Admission short-term (non-respite): Admission for short-term residential care for any purpose other than respite care of a carer. It includes rehabilitation.

Assessment (nutritional assessment): Detailed, specific and in-depth evaluation of a subject's nutritional status undertaken by a professional with nutritional expertise. It is usually performed when there are serious nutritional problems and typically following nutritional screening.

Baseline: The original data of a study or a model that are used for subsequent comparisons

Bed-days: Total number of days over which beds are occupied. They are calculated by multiplying the number of patients by their length of hospital stay.

Bed-day cost: The cost of a bed-day.

BMI: Body mass index.

Body mass index (BMI): Body mass index (weight (kg)/height^2 (m^2)) is a measure of weight status. The adjustment for height allows people to be categorised as underweight, desirable weight, overweight and obese.

Care home: Residential setting where residents access services, which may range from personal and nursing care, to other special types of care such as palliative care or care for the elderly mentally ill. Individual care homes may provide one or more of these services. 'Residential care homes' are now often referred to as 'care homes' and 'nursing homes' as 'care homes with nursing'.

CASSR: Council with Adult Social Services Responsibility.

CG: Clinical guideline.

CCG: Clinical commissioning group.

Clinical commissioning groups (CCGs): Groups of GP practices with the responsibility for commissioning most health and care services for patients in England, as set out in the Health and Social Care Act 2012. CCGs are made up of doctors, nurses, dietitians, pharmacists and other professionals, who work in partnership with local authorities and local communities. They became legal entities in 2013 after the abolition of Primary Care Trusts (PCTs).

Confidence interval: In statistics, a confidence interval (CI) is a range of values (e.g. treatment effects) calculated from observations on samples that are believed to contain the true parameter value (true treatment effect) with a stated probability. The 95% CI implies that there is 95% confidence that the true value (treatment effect) lies within this interval. The CI helps interpret the results of clinical trials by placing lower and upper limits on the likely size of any true effect.

Day care (community): The Information Centre defines day care as attendance at a day centre for day care and/or meals and includes the attendance at training centres and luncheon clubs.

Day cases (hospital): Elective inpatients who have been admitted for treatment only for the day. They represent single spells with duration of zero days.

Dietary advice (dietary counselling): Advice provided by a qualified healthcare worker to modify the quantity, texture and/or proportions of food ingested.

Enteral tube feeding (ETF): Use of a tube to deliver a feed directly into the stomach or gut.

ETF: Enteral tube feeding.

Excess bed-days: Length of stay above the trim point (cut-off point), above which length of stay is considered to be unusually long. Technically it is defined by the following equation: trim point = Q1 + 1.5 x (Q3-Q1), where Q1 is the national lower quartile for length of stay and Q3 is the national upper quartile.

Excess bed-day cost: Cost of an excess bed-day. This cost is usually lower than bed-day cost because it typically involves the cost of basic care and hotel costs, including laundry service, but not the cost of other treatments, such as the cost of surgery.

GP: General practitioner.

Healthcare resource groups (HRG): A coding system involving groups of similar diagnoses or procedures and similar resources.

HES: Hospital episode statistics.

HETF: Home enteral tube feeding

Heterogeneity (lack of homogeneity): Differences between studies used in a meta-analysis, e.g. due to differences in populations and outcome variables (or differences in the definition of the same variable). Heterogeneous studies are analysed using a random effect (rather than a fixed effect) meta-analysis, but the decisions to do so should take into account study characteristics and not depend only on statistical tests of heterogeneity (e.g. the I^2 statistic).

Home care: The definition of home care, as used by The Information Centre, follows (as closely as possible) that which was used in the central data collection HHI return (home help and home care services for adults). The categories home help/care (meaning all care that is not a short-term break in the client's own home) and overnight short-term break (for the benefit of the client) that is provided in the client's own home are combined. The number of contact hours range from 2 or less to more than 10 hours a week.

Home enteral tube feeding (HETF): Enteral tube feeding in the community setting.

Home parenteral nutrition (HPN): Parenteral nutrition in the community setting.

HPN: Home parenteral nutrition.

Length of hospital stay: Mean (average) and median (middle rank) of a spell (see Spell). Day cases (day admissions) which have a length of stay of zero days are not included in this calculation.

Malnutrition: State of nutrition in which a deficiency of energy, protein and/or other nutrients causes measurable adverse effects on tissue/body form (body size, shape and composition) and function and on clinical outcomes (in this report malnutrition is not used to describe overweight/obesity). In this report malnutrition is generally identified with the Malnutrition Universal Screening Tool ('MUST').

Malnutrition Universal Screening Tool ('MUST'): Nutrition screening tool to identify adults who are malnourished, at risk of malnutrition (undernutrition), or obese. It also includes management guidelines which can be used to develop a care plan. It can be used in hospitals, community and other care settings and by a range of workers. A person is considered to be at high risk of malnutrition if the body mass index (BMI) is <18.5 kg/m^2, or has suffered unintentional weight loss >10% within the previous 3–6 months, or a combination of a BMI 18.5–20 kg/m^2 and unintentional weight loss of 5–10% body weight in the previous 3–6 months. In the acute hospital setting no intake or likely no intake for >5 days is also a criterion for high risk of malnutrition. Medium risk of malnutrition is identified by the presence of either a BMI 18.5–20 kg/m^2 or unintentional or weight loss of 5–10% of body weight in the previous 3–6 months.

Meta-analysis: Statistical procedure used to amalgamate the results of two or more independent studies to establish a single quantitative estimate of a treatment effect. The meta-analysis can involve a fixed-effect model that aims to establish a single quantitative common true effect size (i.e. the differences between studies are simply due to random error associated with each study). In contrast, a random-effects model assumes that study populations differ from each other in ways that could affect the treatment effect (i.e. the differences between studies are due both to random error and real differences in effect size). In the fixed-effect model, there is only one true effect size, whereas in the random-effects model there is a range of effect sizes, which means that the summary statistic represents the average of a distribution of values. Judgment is necessary to decide which studies to pool together in a single meta-analysis. Sometimes it is inappropriate or misleading to establish a summary statistic if the studies are intrinsically different (equivalent to mixing apples and oranges).

'MUST': Malnutrition Universal Screening Tool.

NICE: National Institute for Health and Care Excellence.

Nutritional support: Provision of nutrients orally or by tube and/or intravenously (parenterally) with the view of improving or maintaining a person intravenously (parenterally) and avoiding complications of an underlying disease.

Older adults: Subjects aged 65 years and over (see also Younger adults).

Oral nutrition support: Alterations in food and/or fluid intake with a view to increasing dietary intake or avoiding problems due to an underlying disease. The support may include the following: dietary advice on how to increase intake or exclude certain food items or constituents; fortification of food with nutrients; provision of snacks and oral nutritional supplements; changes in the texture of food and fluid; and change in the frequency and pattern of meal ingestion.

Operating costs: Ongoing costs (excludes capital costs).

Overhead costs: Extra costs that are not directly linked to the level of patient activity, but which have to be apportioned to service costs, e.g. overhead costs related to salaries of healthcare workers.

PbR: Payment by Results.

PCT: Primary care trust.

PN: Parenteral nutrition.

P value: The probability of observing an effect or a difference by chance, when there is no real effect or difference. By tradition a P value of <1 in 20 ($P < 0.05$) is taken to be statistically significant.

Payment by Results (PbR): Funding system in England in which commissioners pay healthcare providers for each patient seen or treated. The payments take into account the complexity of care. A coding system (Health Resource Groups; HRG) facilitates the process.

Parenteral nutrition (PN): Nutrition provided intravenously, typically involving an infusion of amino acids, glucose, fat, vitamins, trace elements and electrolytes.

Prevalence: The number of people with a particular condition present within a population. It may be expressed as a percentage (per 100 of population) or per thousand or per million of population.

Primary care: Primary care is generally considered to be healthcare provided outside acute and mental health trusts, with the aim of meeting local care needs. It includes services provided by GPs, nurses, dietitians and pharmacists. Patients may initially contact their primary care practitioner(s) with their healthcare problems, but they may be referred to secondary care practitioners in hospital or mental health units for special investigation and treatment (see also Secondary care, which describes the grey area between primary and secondary care).

QS: Quality standard.

Randomised controlled trial (RCT): A study in which subjects allocated at random to intervention and control groups are followed-up to establish differences in outcome. The RCT may include more than one intervention and more than one control group, e.g. the control group could involve no treatment or routine care.

RCT: Randomised controlled trial.

Screening (nutritional screening): A rapid, simple and general procedure used by nursing, medical or other staff, often at first contact with the patient, to detect subjects who have significant nutritional problems or risks of such problems, so that a clear plan of action can be implemented, e.g. simple dietary measures or referral for expert help.

Secondary care: Secondary care generally refers to healthcare provided by medical specialists and other health professionals, who generally do not have first contact with patients. However, it includes care in a hospital emergency department, where patients may be seen and treated directly by specialists without prior referral. Furthermore, some secondary care could operate outside the hospital setting and some primary care could operate within the hospital setting (e.g. primary care hospitals dedicated to rehabilitative and palliative care).

Sensitivity analysis: Statistical method in which the underlying assumptions are altered to test the robustness of the results and conclusions. It quantifies the extent to which changes in an input variable alters the value of an outcome variable. Uncertainty may arise from missing data and methodological imprecision. In one-way sensitivity analysis each parameter is varied individually, while other variables are kept constant. In two-way sensitivity analysis (the commonest type of multi-way sensitivity analysis) two parameters are varied simultaneously, while other variables are kept constant. Sensitivity analysis can also be used to establish relationships between input and output variables and to help make messages more understandable.

Spell (hospital spell): Period between admission and discharge or death for the same patient being managed by the same provider. Where a patient has more than one distinct admission on the same day, each should be counted separately.

Systematic review: Critical objective appraisal of evidence, conducted according to explicit and reproducible methodology in order to reduce the risk of bias and random errors. A systematic review does not necessarily include a meta-analysis.

Tariff: Fixed prices for unit healthcare provided by the Department of Health which are used as the basis for payment by results.

Trim point: See Excess bed-days

Younger adults: Subjects aged 18–64 years (see also Older adults).

Part E

References

1. Elia M. (Chairman and Editor), Stratton R, Russell C, Green C, Pang F. The cost of disease-related malnutrition in the UK and economic considerations for the use of oral nutritional supplements (ONS) in adults. Health Economic Report on Malnutrition in the UK: BAPEN; 2005.
2. Elia M, Stratton RJ. Calculating the cost of disease-related malnutrition in the UK in 2007. In: Combating malnutrition: recommendations for action. A report from the Advisory Group on Malnutrition led by BAPEN ed: M Elia, C.A. Russell: BAPEN, 2009.
3. Ljungqvist O, van Gossum A, Sanz ML, de Man F. The European fight against malnutrition. *Clin Nutr* 2010; **29**(2): 149-50.
4. Rice N, Normand C. The cost associated with disease-related malnutrition in Ireland. *Public Health Nutr* 2012; **15**(10): 1966-72.
5. Harker R, (Social and General Statistics). NHS funding and expenditure (last updated 03 April 2012); http://www.nhshistory.net/parlymoney.pdf, 2012.
6. Care Quality Commission. Time to listen in NHS hospitals. Dignity and nutrition inspection programme 2012, 2013.
7. Care Quality Commission. Time to listen in NHS care homes. Dignity and nutrition inspection programme 2012, 2013.
8. The Mid-Stafforshire NHS Foundation Trust Public Inquiry (Chaired by Robert Francis QC). Report of the Mid Staffordshire NHS Foundation Trust Public Inquiry. Volume 1: Analysis of evidence and lessons learned (part 1). London: The Stationery Office; 2013.
9. The Mid-Stafforshire NHS Foundation Trust Public Inquiry (Chaired by Robert Francis QC). Report of the Mid Staffordshire NHS Foundation Trust Public Inquiry. Volume 2: Analysis of evidence and lessons learned (part 2). London: The Stationery Office; 2013.
10. The Mid-Stafforshire NHS Foundation Trust Public Inquiry (Chaired by Robert Francis QC). Report of the Mid Staffordshire NHS Foundation Trust Public Inquiry. Volume 3: Present and future annexes. London: The Stationery Office; 2013.
11. The Information Centre (NHS). Hospital Episode Statistics: Admitted Patient care 2011-12 Summary report http://www.hscic.gov.uk/catalogue/PUB08288. 2012.
12. NICE. QS24 Nutrition support in adults: NICE support for commissioners and others using the quality standard on nutrition support in adults *http://publicationsniceorguk/quality-standard-for-nutrition-support-in-adults-qs24/development-sources* 2012.
13. NICE. QS24 Quality Standard for nutrition support in adults *http://publicationsniceorguk/quality-standard-for-nutrition-support-in-adults-qs24* 2012.
14. NICE. Costing report (nutrition support in adults: oral nutrition support, enteral tube feeding and parenteral nutrition, CG32). Implementing NICE guidance in England. http://www.nice.org.uk/nicemedia/live/10978/29987/29987.pdf. 2006.
15. NICE. CG32 Nutrition support in adults. http://guidance.nice.org.uk/CG32/NICEGuidance/pdf/English: National Collaborating Centre for Acute Care; 2006.
16. Department of Health. Annual report and accounts 2011-12. London: The Stationery Office; 2012.
17. Hospital Episode Statistics (HES on line http://www.hscic.gov.uk/catalogue/PUB09624). NHS Accident and Emergency (Experimental Statistics) - Tables 2013.
18. The Information Centre. Mental Health: Annual report MHDMDS return - England 2011-12, initial national figures: Health and Social Care Information Centre; 2013.
19. The Information Centre. Mental Health Bulletin: Annual report from MHMDS - England 2011-12: National reference tables http://www.hscic.gov.uk/catalogue/PUB10347. 2013.
20. Health and Social Care Information Centre. Trends in consultation rates in General Practice 1995-2009: Analysis of QRESEARCH database accessed 02.05.13 (http://www.hscic.gov.uk/pubs/gpcons95-09) 2009.
21. Russell CA, Elia M. Nutrition screening survey in the UK in 2007. A report by BAPEN: BAPEN, 2008.
22. Russell CA, Elia M. Nutrition screening survey in the UK in 2008. A report by BAPEN: BAPEN, 2009.
23. Russell CA, Elia M. Nutrition Screening Survey in the UK and Republic of Ireland in 2010. A report by BAPEN: BAPEN, 2011.
24. Russell CA, Elia M. Nutrition Screening Survey in the UK and Republic of Ireland in 2011. A report by BAPEN: BAPEN, 2012.
25. Russell CA, Elia M. Nutrition Screening Surveys in Hospitals in England, 2007-2011: A report based on the amalgamated data from the four Nutrition Screening Week surveys undertaken by BAPEN in 2007, 2008, 2010 and 2011: BAPEN, 2014.
26. Elia M (Chairman and Editor). The 'MUST' report. Nutritional screening for adults: a multidisciplinary responsibility. Development and use of the 'Malnutrition Universal Screening Tool' ('MUST') for adults. A report by the Malnutrition Advisory Group of the British Association for Parenteral and Enteral Nutrition: BAPEN, 2003.
27. Rust AL, Cawood AL, Walters E, Stratton RJ, Elia M. Prevalence of malnutrition in hospital outpatients. *Proc Nutr Soc* 2010; **69 (OCE2)**: E150.

28. Cawood AL, Elia M, Sharp SK, Stratton RJ. Malnutrition self-screening by using MUST in hospital outpatients: validity, reliability, and ease of use. *Am J Clin Nutr* 2012; **96**(5): 1000-7.
29. McGurk P, Jackson JM, Elia M. Rapid and reliable self-screening for nutritional risk in hospital outpatients using an electronic system. *Nutrition* 2013; **29**(4): 693-6.
30. Gerasimidis K, Keane O, Macleod I, Flynn DM, Wright CM. A four-stage evaluation of the Paediatric Yorkhill Malnutrition Score in a tertiary paediatric hospital and a district general hospital. *Br J Nutr* 2010; **104**(5): 751-6.
31. McCarthy H, Dixon M, Crabtree I, Eaton-Evans MJ, McNulty H. The development and evaluation of the Screening Tool for the Assessment of Malnutrition in Paediatrics (STAMP(c)) for use by healthcare staff. *J Hum Nutr Diet* 2012; **25**(4): 311-8.
32. Moy RJD, Smallman S, Booth IW. Malnutrition in a UK children's hospital. *J Hum Nutr Dietet* 1990; **3**(2): 93-100.
33. Joosten KF, Hulst JM. Prevalence of malnutrition in pediatric hospital patients. *Current opinion in pediatrics* 2008; **20**(5): 590-6.
34. Hecht C, Weber M, Grote V, Daskalou E, Dell'Era L, Flynn D, et al. Disease associated malnutrition correlates with length of hospital stay in children. *Clin Nutr* 2015; **34**(1): 53-9.
35. McGurk P, Cawood A, Walters E, Stratton RJ, Elia M. The burden of malnutrition in general practice. *Gut* 2012; **61 (Suppl 2)**: A18 (OC-042).
36. Russell CA, Elia M. Nutrition Screening Surveys in Care Homes in England, 2007-2011: A report based on the amalgamated data from the four Nutrition Screening Week surveys undertaken by BAPEN in 2007, 2008, 2010 and 2011: BAPEN, 2015.
37. Parsons EL, Cawood AL, Warwick H, Smith TR, Elia M, Stratton RJ. Malnutrition risk varies according to nutrition intervention in care homes. *Clin Nutr Suppl* 2010; **5 (2)**: 161 (PP353).
38. King CL, Blaikley S, Hackson A, Stroud MA, Elia M, Stratton RJ. Prevalence of malnutrition risk using the malnutrition Universal Screening Tool ('MUST') within a distric nurse-referred population. *Proc Nut Soc* 2004; **63 (Supple 1a)** 27A.
39. Kruizenga HM, Wierdsma NJ, van Bokhorst MA, de van der S, Haollander HJ, Jonkers-Schuitema CF, et al. Screening of nutritional status in The Netherlands. *Clin Nutr* 2003; **22**(2): 147-52.
40. Meijers JM, Schols JM, van Bokhorst-de van der Schueren MA, Dassen T, Janssen MA, Halfens RJ. Malnutrition prevalence in The Netherlands: results of the annual dutch national prevalence measurement of care problems. *Br J Nutr* 2009; **101**(3): 417-23.
41. Holland K. Factsheet: Learning Disabilities British Institute of Learning Disbilities (http://www.trianglehousing.org.uk/cmsfiles/Learning%20Hub/Support%20and%20Care/factsheet_learning_disabilities_11.pdf). 2011: 6.
42. Hove O. Weight survey on adult persons with mental retardation living in the community. *Research in developmental disabilities* 2004; **25**(1): 9-17.
43. Maaskant MA, van Knijff-Raeven AGM, Lantman-de Valk SL, Veenstra M. Weight status of persons with intellectual disabilities. *J Appl Res Intell Disab* 2009; **22**: 426-32.
44. Bronberg RA, Alfaro EL, Bejarano IF, Dipierri JE. [Prevalence of malnutrition in institutionalized intellectually disabled patients]. *Medicina* 2011; **71**(1): 1-8.
45. Bhaumik S, Watson JM, Thorp CF, Tyrer F, McGrother CW. Body mass index in adults with intellectual disability: distribution, associations and service implications: a population-based prevalence study. *Journal of intellectual disability research : JIDR* 2008; **52**(Pt 4): 287-98.
46. Hill CM, Watkins J. Statutory health assessments for looked-after children: what do they achieve? *Child: care, health and development* 2003; **29**(1): 3-13.
47. Rodrigues VC. Health of children looked after by the local authorities. *Public Health* 2004; **118**(5): 370-6.
48. Hadfield SC, Preece PM. Obesity in looked after children: is foster care protective from the dangers of obesity? *Child: care, health and development* 2008; **34**(6): 710-2.
49. NHS England. Average daily available occupied beds timeseries http://www.england.nhs.uk/statistics/statistical-work-areas/bed-availability-and-occupancy/bed-data-day-only/2014.
50. NHS England. Average Daily Available and Occupied Beds Timeseries http://www.england.nhs.uk/statistics/statistical-work-areas/bed-availability-and-occupancy/bed-data-overnight/; 2014.
51. Health and Social Care Information Centre. Personal Social Services Adult Social care Survey, England 2011-12 (Final Resease) http://www.hscic.gov.uk/catalogue/PUB09271/per-soc-ser-adu-soc-car-sur-eng-2011-12-fin-report.pdf; 2012.
52. Harris DG, Davies C, Ward H, Haboubi NY. An observational study of screening for malnutrition in elderly people living in sheltered accommodation. *J Hum Nutr Diet* 2008; **21**(1): 3-9; quiz 10-2.
53. Ralf AF, Cawood AL, Hubbard GP, Stratton RJ. Prevalence of malnutrition in Sheltered Housing Schemes in Wiltshire and Somerset. *Proc Nutr Soc* 2010; **69**: OC72.

54. Elia M, Russell CA, on behalf of the Group on Nutrition and Sheltered Housing. Screening for malnutrition in sheltered housing http://www.bapen.org.uk/professionals/publications-and-resources/bapen-reports/screening-for-malnutrition-in-sheltered-housing. Redditch: BAPEN; 2009.
55. Finch S, Doyle W, Lowe C, Bates CJ, Prentice A, Smithers G, et al. National Diet and Nutrition Survey: people aged 65 years and over. *The Stationery Office, London* 1998.
56. Stratton RJ, Hebuterne X, Elia M. A systematic review and meta-analysis of the impact of oral nutritional supplements on hospital readmissions. *Ageing Res Rev* 2013; **12**(4): 884-97.
57. Arora A, A. C, Kelly E, Stoye G. Public payment and private provision. Research report by Institute: the changing landscape of healthcare in the 2000's. London: Nuffield Trust www.nuffieldtrust.org.uk/public-payment-privateprovision-2000s; 2013.
58. Laing & Buisson obotBPEVCA. The Role of Private Equity in UK Health Care Services. London, 2012.
59. Snider JT, Linthicum MT, Wu Y, LaVallee C, Lakdawalla DN, Hegazi R, et al. Economic burden of community-based disease-associated malnutrition in the United States. *JPEN J Parenter Enteral Nutr* 2014; **38**(2 Suppl): 77S-85S.
60. Linthicum MT, Thornton Snider J, Vaithianathan R, Wu Y, LaVallee C, Lakdawalla DN, et al. Economic burden of disease-associated malnutrition in China. *Asia-Pacific journal of public health / Asia-Pacific Academic Consortium for Public Health* 2015; **27**(4): 407-17.
61. Muller MC, Uedelhofen KW, Weidemann UCH. CEPTON-Studie: Mangelernahrung in Deutschland. Erlangen:Bressler Druck. 2007.
62. Freijer K, Tan SS, Koopmanschap MA, Meijers JM, Halfens RJ, Nuijten MJ. The economic costs of disease related malnutrition. *Clin Nutr* 2013; **32**(1): 136-41.
63. Kok L, Scholte R, with the assistance of Koopmans C. Malnutrition underestimated: The costs of malnurition and the return on medical nutrition. SEO Economic Research. http://www.seo.nl/uploads/media/2014-11a_Malnutrition_underestimated.pdf. Amsterdam; 2014.
64. Elia M, Smith R. Nutritional support in the home setting. In: Caballero B A, L, Prentice, A, editor. Encyclopedia of Human Nutrition (3rd edition). 3 ed. London: Academic Press; 2013.
65. The NHS Staff Counicl. NHS terms and conditions of service handbook. Amendment number 26. Pay Circular (AforC) 2/2012. , 2012.
66. Curtis JP. Unit Costs of Health and Social Care 2012: Personal Social Services Research Unit, University of Kent; 2012.
67. Elia M, Stratton RJ. Geographical inequalities in nutrient status and risk of malnutrition among English people aged 65 y and older. *Nutrition* 2005; **21**(11-12): 1100-6.
68. Elia M, Zellipour L, Stratton RJ. To screen or not to screen for adult malnutrition? *Clin Nutr* 2005; **24**(6): 867-84.
69. Elia M, Stratton RJ. Considerations for screening tool selection and role of predictive and concurrent validity. *Curr Opin Clin Nutr Metab Care* 2011; **14**(5): 425-33.
70. Raslan M, Gonzalez MC, Dias MC, Nascimento M, Castro M, Marques P, et al. Comparison of nutritional risk screening tools for predicting clinical outcomes in hospitalized patients. *Nutrition* 2010; **26**(7-8): 721-6.
71. Stratton RJ, Bowyer G, Elia M. Fewer complications with liquid supplements than food snacks in fracture patients at risk of malnutrition. *Clin Nutr* 2007; **2 (Suppl 2)**: 9 (0014).
72. Elia M, Normand C, Laviano A, Norman K. A systematic review of the cost and cost-effectiveness of standard oral nutritional supplements in the community including care homes, with and without use in hospital; 2015 (submitted).
73. Elia M, Normand C, Norman K, Laviano A. A systematic review of the cost and cost-effectiveness of standard oral nutritional supplements in the hospital setting. *Clin Nutr (submitted)* 2015.
74. van der Schureren M EM, Gramlich L, Johnson, MP, Lim SL, Philipson T., Prado Cm. Clinical and economic outcomes of nutrition interventions across the contnuum of care. *Ann NY Acad Sci* 2014: in press.
75. Health and Social Care Information Centre. GP List Populations of Primary Care Organisations (aggregated to Strategic Health Authorities) https://www.google.co.uk/search?q=GP+List+Populations+of+Primary+Care+Organisations+(aggregated+to+Strategic+Health+Authorities)%09%09%09%09&sourceid=ie7&rls=com.microsoft:en-gb:IE-SearchBox&ie=&oe=&gws_rd=ssl2011.
76. Office of National Statistics. 2011 Census: Key Statistics for local authorities in England and Wales (http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-286262)2011
77. Health and Social Care Information Centre. Community Care Statistics, Social services activity - England 2011-12 Provisional release: Anne A national tables (http://www.hscic.gov.uk/catalogue/PUB09271); 2012.
78. NCEPOD. Parenteral Nutrition: a mixed bag. London: National Confidential Enquiry into Patient Outcome and Death, 2010.

79. Barker K, Alltimes G, Bichard L, greengross S, Le Grand J. Final report of the Commission on the Future HHealth and Social Care in England. Kings Fund. http://www.kingsfund.org.uk/publication/new-settlement-health-and-social-care. London: The Kings Fund; 2014.
80. Appleby J. What are we spending on the English NHS? *BMJ* 2013; **347**: f6287.
81. Smith T, Micklewright A, Hirst A, Stratton R, Baxter J. Annual BANS report 2011. A report By the British Artificial Nutrition Survey (BANS), a committee of BAPEN; 2011.
82. Health and Social Care Information Centre. Hospital Estates and Facilities Statistics 2011-12 (http://webarchive.nationalarchives.gov.uk/20130402145952/http://transparency.dh.gov.uk/2012/10/16/hospitalestatesstatistics-2011-12/). 2012.
83. Elia M. (Chairman and Editor), Stratton R, Russell C, Green C, Pang F. The cost of disease-related malnutrition in the UK and economic considerations for the use of oral nutritional supplements (ONS) in adults. A report by The Health Economic Group of The British Association for Parenteral and Enteral Nutrition (BAPEN): BAPEN, 2005.
84. Delmi M, Rapin C-H, Bengoa J-M, Delmas PD, Vasey H, Bonjour J-P. Dietary supplementation in elderly patients with fractured neck of femur. *Lancet* 1990; **335**: 1013-6.
85. Gariballa SE, Parker SG, Taub N, Castleden CM. A randomized, controlled, a single-blind trial of nutritional supplementation after acute stroke. *JPEN* 1998; **22**(5): 315-9.
86. Potter JM, Roberts MA, McColl JH, Reilly JJ. Protein energy supplements in unwell elderly patients: a randomized controlled trial. *JPEN* 2001; **25**: 323-9.
87. Vlaming S, Biehler A, Hennessey EM, Jamieson CP, Chattophadhyay S, Obeid OA, et al. Should the food intake of patients admitted to acute hospital services be routinely supplemented? A randomized placebo controlled trial. *Clin Nutr* 2001; **20**: 517-26.
88. Tidermark J, Ponzer S, Carlsson P, Soderqvist A, Brismar K, Tengstrand B, et al. Effects of protein-rich supplementation and nandrolone in lean elderly women with femoral neck fractures. *Clin Nutr* 2004; **23**(4): 587-96.
89. Beattie AH, Parch AT, Baxter JP, Pennington CR. A randomised controlled trial evaluating the use of enteral nutritional supplements postoperatively in malnourished surgical patients. *Gut* 2000; **46**: 813-8.
90. Saluja SS, Kaur N, Shrivastava K. Enteral nutrition in surgical patients. *Surgery Today* 2002; **32**: 627-78.
91. Gazzotti C, Arnaud-Battandier F, Parello M, Farine S, Seidel L, Albert A, et al. Prevention of malnutrition in older people during and after hospitalisation: results from a randomised controlled clinical trial. *Age Ageing* 2003; **32**: 321-5.
92. Olofsson B, Stenvall M, Lundstrom M, Svensson O, Gustafson Y. Malnutrition in hip fracture patients: an intervention study. *Journal of clinical nursing* 2007; **16**(11): 2027-38.
93. Brown KM, Seaborook N. Effect of nutrition on recovery after fractured femur. *Medical Audit News* 1992; **2**(1): 10-2.
94. Brown KM, Seabrook NA. Nutritional influences on recovery and length of hospital stay in elderly women following femoral neck fracture. *Proc Nut Soc* 1992; **51**: 132A.
95. Hankins C. Dietary supplementation with Sustagen in elderly patients with fractured neck of femur (PhD thesis). *University of Sydney,* 1996.
96. Cawood AL, Smith A, Pickles S, Church S, Dalrymple-Smith J, Elia M, et al. Effectiveness of implementing 'MUST' into care homes within Peterborough primary care trust, England. *Clin Nutr* 2009; **4**(Suppl 2): 81 (P133).
97. Baggaley E, Whincup L, Ashman KE, Cawood AL, Davies DP, Burns E, et al. Effectiveness of implementing a nurse led policy for the management of malnutrition. *Clin Nutr* 2013; **32 (Suppl 1)**: S231
98. Weekes CE, Emery W, Elia M. A cost effectiveness analysis of dietary counselling and food fortification in malnourished outpatients with severe chronic obstructive pulmonary disease *Submitted* 2014.
99. Smith T, Micklewright A, Hirst A, Gowan H, Baxter J. Annual BANS report 2010. A report By the British Artificial Nutrition Survey (BANS), a committee of BAPEN; 2010.

Part F

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