Resource use and cost of annual health checks in primary care for people with intellectual disabilities

Monica Panca[1] MSc, Marta Buszewicz[1] MRCGP, André Strydom[2] PhD, Angela Hassiotis[3] PhD, Catherine A Welch[4] PhD, Rachael M Hunter[1] MSc

[1]UCL Institute of Epidemiology & Health Care, Research Department of Primary Care & Population Health, Royal Free Campus, Rowland Hill Street, London NW3 2PF
[2]Institute of Psychiatry Psychology and Neuroscience, King's College London, 16 De Crespigny Park, London SE5 8AF
[3]UCL Division of Psychiatry, 149 Tottenham Court Road, London W1T 7NF
[4]Department of Cardiovascular Sciences, University of Leicester, Leicester, LE3 9QP

Correspondence to:
Monica Panca
Research Associate in Health Economics
Research Department of Primary Care & Population Health
UCL Institute of Epidemiology & Health Care
Royal Free Campus
Rowland Hill Street
London NW3 2 PF
Tel: 02077940500 ext. 36323
m.panca@ucl.ac.uk

Running title: Cost of annual health checks in intellectual disabilities

Abstract

Background

The Annual Health Check (AHC) program, as part of a Directed Enhanced Service (DES), offers an incentive to general practitioners (GPs) in England to conduct health checks for people with intellectual disabilities (IDs). The aim of this analysis was to estimate the impact on healthcare costs of AHCs in primary care to the NHS in England by comparing adults with ID who did or did not have AHCs using data obtained from The Health Improvement Network (THIN).

Methods

Two hundred and eight records of people with ID from THIN database were analysed. Baseline healthcare resource use was captured at the time the first AHC was recorded (i.e., index date), or the earliest date after 1st of April 2008 for those without an AHC. We examined the volume of resource use and associated costs that occurred at the time AHCs were performed, as well as before and after the index date. We then estimated the impact of AHCs on healthcare costs.

Results

The average cost of AHC was estimated at £142.57 (95%CI £135.41 to £149.74). Primary, community and secondary healthcare costs increased significantly after the index date in the no AHC group due to higher increase in resource utilisation. Regression analysis showed that the expected healthcare cost for those who have an AHC is 56% higher than for those who did not have an AHC. Age and gender were also associated with increase in expected healthcare cost.

Conclusion

The level of resource utilisation increased in both (AHC and no AHC) groups after the index date. Although the level of resource use before index date was lower in the no AHC group, it increased after the index date up to almost reaching the level of resource utilisation in the AHC group. Further research is needed to explore if the AHCs are effective in reducing health inequalities.

Key words: Healthcare services, cost, annual health check, intellectual disability

Introduction

An increasing proportion of the people with intellectual disability (ID) lives in the community and often has associated health issues, such as cardiovascular, respiratory, gastrointestinal, endocrine, mental health problems, and epilepsy (Cooper *et al.* 2007; Emerson *et al.* 2013). People with ID are less likely to access routine health checks, which may be a result of needing to rely on their family/carers to attend general practitioner (GP) appointments (Alborz *et al.* 2005). Therefore, appropriate healthcare is essential for this population given the high morbidity burden, and the early intervention of their GP is therefore very important to their overall health (Emerson & Baines 2010). In the UK, the GP is the main primary health care provider of health care for people with ID. Implementation of a management plan, compliance and continuity of care for people with ID could help the identification of important comorbidities, which might lead to a reduction in avoidable health issues and deaths if effectively managed.

The National Health Service (NHS) England introduced the Annual Health Check (AHC) program for people with ID in 2008/2009 as a Directed Enhanced Service (DES) in primary care. This enhanced service is designed to encourage GP practices to identify all patients aged 14 and over with ID, to maintain a ID 'health check' register and offer them AHCs, which will include producing a health action plan (The NHS Confederation (Employers) 2012). AHCs for people with ID are designed to improve their health by identifying unmet needs, potentially treatable conditions, and timely access to further care. The approximate number of those with ID and significant impairment in functional abilities known to service providers in England and thus eligible for AHCs was estimated to be over 214,000 in 2013/2014 (Hatton *et al.* 2016). The Royal College of General Practitioners (RCGP) produced guidelines that GPs should carry out AHCs for all people with an ID（RCGP 2010). This recommends that all health checks include an assessment of feeding, bowel and bladder functions, assessment of behavioural disturbance and assessment of vision and hearing. There are also some syndrome-specific checks that GPs should carry out for people with specific conditions associated with particular physical health problems, such as in people with Down syndrome. In 2012/2013, 52% of eligible people with IDs received an AHC (Glover & Niggebrugge 2013).

It has been shown that people with ID from general practices that had enrolled in the AHC program were offered significantly more general health measurements, blood tests, and specific health screening compared to general practices that had not enrolled in the program, and identification rates for previously un-identified health problems were also higher (Buszewicz *et al.* 2014).

Undertaking comprehensive AHCs may however require considerable effort in terms of resource use which will be associated with costs within primary healthcare services. Health checks were estimated to cost the NHS £60.7 million over 3 years based on estimates of associated activity, costs and uptake by general practices (DoH 2009).

There is limited published literature quantifying the cost impact of AHCs in people with IDs and, for those existing, the setting, population and methodology used make comparison across the studies difficult. A study conducted in Greater Glasgow Health Board area, Scotland, in 100 people with ID (50 of whom received an AHC) around the time of the introduction of AHCs in England suggested that there were no increased costs in terms of service use, and concluded that AHCs are relatively inexpensive (mean cost per person estimated at £82) and do not have significant service implications (Romeo *et al.* 2009).

In addition, a study conducted in Australia (Gordon *et al.* 2012) showed no significant differences in healthcare costs over 12 months between people with ID who received health assessments compared with people who did not receive health assessments (AUD 4523 vs. AUD 4466). The authors concluded that health assessments led to significantly increased health promotion, but overall created a neutral impact on costs, while at the same time the assessment encouraged more targeted patient services.

The aim of this analysis was to estimate the resource use and the impact on healthcare costs of AHCs in primary care to the NHS in England by comparing adults with ID who did or did not have AHCs using data obtained from The Health Improvement Network (THIN). This included the cost of the AHC, as well as investigating whether the AHCs generated additional costs to the NHS by identifying additional medical care needed.

Methods

Data source and study population

The THIN research database is a longitudinal primary care database of over 12 million anonymised primary care medical records collected from 587 general practices in the UK, covering 5.7% of the UK population in 2014. THIN data are representative for the UK population (IMS Health RWES 2016).

The THIN database contains diagnostic and prescribing information recorded by GPs who have opted into the data recording scheme as part of their routine clinical practice and it is used extensively for research purposes. Data are recorded using coded clinical language (Read codes [Chisholm 1990]), which consist of a hierarchically arranged comprehensive list of clinical terms to describe the healthcare of patients in general practice, and encrypted identification

codes from the UK Prescription Pricing Authority (Joint Formulary Committee 2013) classified according to the British National Formulary (BNF) for prescriptions.

The data for this study were extracted from a larger study (Buszewicz *et al.* 2014) which investigated whether the AHC program had improved healthcare for people with ID using data from the THIN research database. English general medical practices were included if, before 1st of January 2009, the average annual recording rates were at least one medical record, one additional health data record, and two prescription records per person per year across the whole practice population, and practice mortality recording rates were similar to general UK population mortality after accounting for the distributions of age and sex. Eligible persons were aged at least 18 years and had known ID identified with specific Read codes used to include them in the practice Quality and Outcomes Framework (QOF) register. The QOF is a system for the performance management and payment of GPs in the NHS in England, Wales, Scotland and Northern Ireland. It was introduced as part of the new general medical services (GMS) contract in April 2004, replacing various other fee arrangements. GP practices are entitled to a payment of £140 (value from April 2017) in any one financial year for each patient aged 14 or over on the GP practices agreed ID register who received an AHC (The NHS Confederation (Employers) (2018). In the program there were 8692 people with ID in 222 incentivised general practices and 918 people with ID in 48 non-incentivised general practices. For our study, we selected 208 medical records from 12 incentivised general practices ensuring that the practices selected covered the full range of social deprivation and different regions. One hundred and two medical records had no entry for an AHC and 106 medical records had at least one entry for AHC. Baseline healthcare resource use was captured at the time of the first AHC (i.e., index date). For people who had no entries for an AHC, we used the earliest date that they could have had an AHC after 1st of April 2008 as their index date. Any access to healthcare was extracted retrospectively for the period of time from the index date until the latest date possible that a contact could be recorded: 31st of December 2011.

Healthcare resource use

Annual Health Check

When identifying relevant Read codes, we used those recommended by the guideline produced to help GPs and practice nurses to organise and perform high quality AHCs in people with ID: weight, height, blood pressure measurement; blood, urine analysis; smoking, alcohol and illegal drugs status; vision, hearing, communication and mobility assessment; immunisation/vaccination status; cervical screening and mammography status; chronic illnesses enquiry; sexual health enquiry; behavioural changes; medication review and

prescriptions; proposed health action plan and syndrome specific medical health checks (RCGP 2010).

Primary care services

Read codes were used to estimate the number of primary healthcare professional contacts before and after the index date, and any other resources accessed. The mean number of primary healthcare contacts was calculated as the sum of all recorded contacts within primary care. Contacts with primary healthcare professionals were classified into the following categories: GP visits (at general practice/home or phone consultation); practice nurse visits (at general practice/home or phone consultation), and community nurse visits (at general practice or clinic/home or phone consultation).

Secondary care services

The mean number of referrals to secondary care services, laboratory, and imaging and other outpatient services, accident and emergency services were calculated. Secondary care is captured in THIN via Read codes either when a person is referred to a secondary care service, or they have an unplanned contact with a secondary care service and a letter is sent to their GP. As the database does not directly capture secondary care service use (only a limited number of general practices are linked to the Hospital Episode Statistics (HES)), some of the data on secondary care services may be incomplete. Hence, we made the following assumptions to estimate secondary care services utilisation: for data recorded on THIN about any type of hospitalisation, the length of stay was calculated by subtracting the admission date from the discharge date from the information recorded within the study period. Where this information was not available, we used the mean length of stay (DoH 2015) for the condition/procedures for which people with ID were hospitalised. Outpatient appointments were accounted for if a referral to an outpatient service was not followed by an entry of "did not attend" or if there was evidence of recording of outcomes of an outpatient contact in the GP records.

Prescriptions

All recorded prescriptions were aggregated for each person, with the number of individual doses prescribed before and after the index date. Net ingredient costs per dose, based on the September 2014 edition of the BNF were applied to the doses recorded, in order to arrive at a total cost of prescriptions issued.

Healthcare resource costs

Costs were estimated by multiplying the number of units used for each relevant resource factor obtained from the THIN database with the corresponding unit cost (Online Supplementary

Table 1). Total costs were measured as average yearly costs by adding up the total primary and secondary care costs, inpatient care costs, outpatient care costs, and prescription costs.

Based on providing evidence of completed AHCs, general practices receive payment under the DES on a quarterly basis calculated from the number of completed AHCs for people with ID undertaken in the previous quarter. Accordingly, we included this payment (£100 per health check at the time we conducted the study) for those who had undergone first AHC in this study ((The NHS Confederation (Employers) (2012)). Where multiple AHCs following the index date AHC were recorded, we considered them as GP visits.

Resource use costs were calculated using cost references from the NHS national schedule of reference costs (DoH 2015) and the Personal Social Services Research Unit (PSSRU) (Curtis 2014). Costs were calculated in 2013/14 UK pounds (£).

Statistical methods

Summaries are presented as means and standard deviations (SD) for continuous outcomes and numbers and percentages (%) for categorical outcomes. The outcomes of interests were the mean number of different types of person-level health services resource utilisation and their associated costs before and after the index date in both (AHC and no AHC) groups. The resource utilisation and associated costs before and after the index date for each group was compared using t-tests. We considered the statistical significance to be at the 5% level.

We then examined factors associated with healthcare costs using negative binomial regression (Cameron & Trivedi 2013), including: the length of time before and after the index date (exposure duration) differed between individual persons, and in particular between the AHC (mean 1.85 years) and the no AHC (mean 3.75 years) groups. The difference between the two groups was predominately because we chose the "earliest possible time point they could have received an AHC" as the index date for the no AHC group; a problem with this is that longer periods of time would likely have been associated with higher number of resource use, and shorter periods of time would likewise be likely to have lower number for resource use. Given that failure to account for variability in exposure duration could bias the regression results, we included exposure duration for each person in the regression analysis to account for the potential number of times the event could have happened (Atkins *et al*. 2013).

The influence of AHC on each individual's healthcare costs was analysed using the negative binomial regression model, adjusting for age and gender, with the total healthcare cost after the index date as response variable, the exposure duration as the offset, and the AHC, age, gender and costs before the index date as explanatory variables. Results are presented as incident rate ratios. We would have attempted to control for severity of the ID, but a large amount of medical

records (>65% in each group) did not have a clear entry for the severity of ID. Analyses were performed using STATA version 14.1 (StataCorp. 2014).

Results

Demographic characteristics

The medical records of identified people with ID (n=208; 106 with AHC and 102 with no AHC) came from 12 incentivised general practices. The number of medical records per general practice ranged from 7 to 36. The groups were fairly well balanced in terms of age and gender. Severity of ID was poorly recorded in both groups. There was an uneven geographical representation; more medical records in the no AHC group were from the South East Coast whereas more medical records in the AHC group were from London. Demographic characteristics are presented in Table 1.

Annual Health Check routine assessments

The mean number (SD) of routine assessments performed during an AHC was 8.83 (4.27) and they were conducted by either practice nurses (48% of the AHCs) or GPs (44% of the AHCs). The mean number of routine assessments per AHC was similar whether they were conducted by practice nurses (9.63; SD 4.00) or GPs (9.34; SD 3.71). There were people with ID who had more than one AHC during the study period. Weight, blood pressure measurements, alcohol status, mobility, hearing and vision assessments and dental examinations were performed and a Health Action Plan was offered at more than 50% of the AHC visits. Other routine assessment included: basic assessment of behaviour and communication, “other medical” (as they were recorded) assessments, smoking status recording, weight monitoring, medication review, health education, and referral for laboratory tests. There was a mean (SD) of 2.18 (2.50) prescriptions issued per AHC visit; 32% of people with ID received prescriptions for central nervous system problems, followed by 18% for cardiovascular system problems. Other prescriptions were issued for skin, respiratory system, gastrointestinal system, and endocrine system problems (see Table 2).

Healthcare resource use and costs

There were statistically significant increases in mean number of contacts with GPs (1.59; *p=0.033*), practice nurses (0.51; *p=0.015*), and community nurses (0.08; *p=0.018*), in the no AHC group after the index date. Statistically significant increases in primary care resource use in the AHC group after the index date were observed in the mean number of GP phone contacts (0.46; *p=0.014*) (see Table 3).

People in the no AHC group had a significant increase in the mean number of unplanned admissions (admissions with no referral letter) (0.06; *p=0.018*), and contacts with community

healthcare services (0.15; *p=0.044*), as well as outpatient contacts (0.59; *p=0.002).* The only statistically significant increase in the AHC group was in the mean number of outpatient contacts (1.15; *p=0.001*) (see Table 3).

The mean number of prescriptions for immune system agents (0.09; *p=0.013*) increased significantly in the AHC group after the index date (see Table 3).

To note is that for both groups the level of resource utilisation increased after the index date. Although the level of resource utilisation before the index date was lower in the no AHC group than in the AHC group, it increased after the index date almost reaching the level of resource utilisation in the AHC group.

The average cost of an AHC was estimated at £142.57 (95%CI £135.41 to £149.74).

There was statistically significant increase in costs for primary care contacts (£96.43; *p=0.020*) and community and secondary care activities (£157.79; *p=0.008*) in the no AHC group after the index date (see Table 4).

Differences in total costs before and after the index date was not statistically significant in any of the groups; in the no AHC group this difference was double that of the AHC group due to a higher increase in resource utilisation after the index date. Even so, the total cost in the AHC group remained higher than in the no AHC group.

The results of the negative binomial regression analysis are detailed in Table 5. Holding other regressors and the standard error constant, the expected healthcare cost for those who have an AHC is 56% higher than for those who did not have an AHC. Similarly, the expected healthcare cost for females was 55% higher than for males. For each additional year of age, the expected healthcare cost is increased by 1.6%.

Discussion

This study analysed the impact of the AHC scheme specifically targeting people with ID in the community setting using the THIN dataset. Based on an in-depth review of healthcare activity following AHCs, our study is more reflective of what happens in “real-life”. The study shows that AHCs had a good coverage of general and specific health assessments of people with ID, which has previously been shown to lead to an increased likelihood of identifying new comorbidities such as gastrointestinal and thyroid disorders, constipation, and being underweight or obese (Buszewicz *et al.* 2014).

In general, resource utilisation was lower in the no AHC group than in the AHC group before the index date; however the resource utilisation increased in both groups after the index date. To note is that the levels of resource utilisation in the no AHC group increased after the index date, almost reaching the levels of those in the AHC group. We observed a significant increase

in contacts with GPs, practice nurses, and community nurses and healthcare services, as well as in outpatient appointments and unplanned hospital admissions for the people that did not receive an AHC. For people that did receive an AHC there was significant increase in GP phone consultations, and outpatient appointments. Hence, we found that the burden of healthcare resources was higher after the index date in both groups, yet significant increases in primary/community and secondary care resources utilisation were noted predominantly in resource use associated with unplanned health care attendances in the no AHC group, whereas this same pattern was not seen in the AHC group. This suggests that AHCs may have helped to identify and manage the type of problems that might otherwise lead to unplanned healthcare resource use.

Our study cannot reveal why people with ID registered with an incentivised general practice did not receive an AHC. A previous study (Buszewicz *et al.* 2014) showed that Read codes identifying that people with ID had been invited to attend a health check were infrequently used, and most general practices only recorded completion of incentivised health checks.

Our study also cannot reveal why people with ID in the no AHC group were seeking significantly more primary/community and secondary care and had more prescriptions for central nervous system after the index date and further research on this is required. It could be that people with more complex health needs (e.g., more severe ID) are more likely to get more healthcare. However, we were unable to conclude that severity of ID potentially increased healthcare resource utilisation due to the fact that the severity of people's ID was seldom recorded in our sample.

People with ID are some of the highest consumers of medications (e.g., psychotropic and anti-epileptic) with high rates of potentially serious side-effects (de Kuijper *et al.* 2010). Our study was unable to conclude that the higher numbers of prescriptions for cardiovascular, central nervous and gastrointestinal problems in the AHC group was driven by the severity of the people's ID or other reasons. However, the number of prescriptions in the AHC group appeared to go down slightly after the index date, as well as the associated costs, which may be due to active health promotion strategies around diet and exercise put in place during the AHCs to avoid potential significant interactions.

Although AHCs result in increased expected costs mainly due to referrals to other services, they appeared to result in better health monitoring and more preventive care (e.g. immunisations), which may be associated with a reduction in unexpected visits and non-elective admissions, and possibly reduced mortality rate. AHCs therefore seem to be effective in reducing health inequalities as intended, although further work to determine the medium to

long term impact of AHCs on outcomes, their long-term costs, and any financial gains from conducting AHCs is needed (Cooper *et al.* 2014).

Strengths and limitations

This is the first study to explore the costs associated with healthcare provision to people with ID using a tool such as the THIN research database. However, the results presented here are different from those reported in another UK study (Romeo *et al.* 2009) where the mean cost of AHCs (£82) was lower than in our study (£143). This may be because we included the general practice reimbursement of £100 per person for completed first AHC. Another explanation could be that in the former study, AHCs were performed by practice nurses, whereas in our study, we found that in 44% of the cases, AHCs were performed by GPs who were costed at a higher rate than practice nurses in our analysis.

One limitation could be that the sample size was too small and therefore this study is possibly underpowered to detect differences in healthcare costs between the AHC and no AHC groups. We conducted a number of statistical tests of changes in health care use before and after the index date and hence some of the significant findings may be by chance. However, although the sample size was small, the longitudinal nature of the dataset, with a mean follow-up of 1.85 years (AHC group) and 3.75 years (no AHC group), generated a rich source of information.

Given that severity of ID is sometimes associated with poorer health, it would have been helpful to adjust for severity of ID in the analysis as this may have accounted for some of the findings. However, over 65% of the medical records in both groups gave no clear indication of the severity of the people's ID and we were therefore unable to adjust for severity of ID in our analysis.

An additional weakness of the study is that we have only included information on healthcare resource use and costs. Improved care as a result of AHCs may also have a positive impact on quality of life, morbidity, and mortality. Morbidity changes may have been captured indirectly through unplanned healthcare attendances, but we had no information available on quality of life and the sample size and follow-up was not sufficient to assess mortality. The wider potential benefits of AHC should be examined these factors further as part of future research.

This analysis was heavily reliant on the accuracy of recording of resource use in Read codes and there may be differences between staff in the quality of Read code recording. In particular, the THIN database only captures secondary care services based on letters sent from secondary care services to practices, and only a limited number of general practices are linked to the Hospital Episode Statistics (HES). Recorded data and assumptions for non-available data were used to inform our assessments of outpatient visits and the length of inpatient care for any type

of intervention detected in the medical records. As a result there may be some missing data, either because of letters not sent to practices about secondary care access or letters not coded in Read codes. Therefore, we may have underestimated the costs associated with hospitalisation as well as the cost of outpatient appointments. We were also unable to comment on the quality or overall content of the entries recorded in people's medical files.

Although these data were collected from the period of 2008-2011 and may not reflect the current practice in healthcare provided for people with ID, it does serve as feasibility study upon which other studies could be modeled. In addition, as this is an observational study the results could have been influenced by unobserved confounding factors contributing to the healthcare costs. Gathering data on patient services from government databases can also be a more efficient way to conduct economic evaluations of services than conducting full scale randomised control trials (Franklin *et al.* 2017).

Conclusion

People with ID that did not have an AHC had a significant increase in unplanned health care use that was not seen in people with AHCs. This suggests that AHCs may have led to more proactive management of health care for people with ID, although AHCs delivered in primary care for people with ID overall led to higher costs. Further research is needed to detect whether an AHC for people with ID translates into improved outcomes, reduced mortality, and better quality of life which may justify the additional cost. Also, our work showed that the analysis of THIN database is feasible and therefore could support a funding application to collect and use a larger sample.

Contributors

MP and RMH developed the analysis strategy for this study. MP undertook the cost analysis and drafted the paper with input from all authors. RMH and CW advised on statistical analysis plan and reviewed the paper. MB, AH and AS contributed to the study plan and reviewed the paper. All authors approved the final manuscript.

Conflict of interests

No conflicts of interest have been declared.

Funding

MB, AS, AH, CW, and RMH received funding from the UK National Institute for Health Research (NIHR) under its Programme Development Grants Programme (grant RP-DG-0611-10003) to develop the ideas and methods that led to this work. The views expressed are those of the author(s) and not necessarily those of the UK National Health System, the NIHR or the Department of Health.

References

Alborz A, McNally R & Glendinning C. (2005) Access to health care for people with learning disabilities in the UK: mapping the issues and reviewing the evidence. *J Health Serv Res Policy* **10**: 173-82.

Atkins D.C., Baldwin S.A., Zheng C., Gallop R.J. & Neighbors C. (2013) A tutorial on count regression and zero-altered count models for longitudinal substance use data. *Psychology of Addictive Behaviors* **27**, 166–77. https://doi: 10.1037/a0029508.

Buszewicz M., Welch C., Horsfall L., Nazareth I., Osborn D., Hassiotis A. et al. (2014) Assessment of an incentivised scheme to provide annual health checks in primary care for adults with intellectual disability: a longitudinal cohort study. *Lancet Psychiatry* **1**, 522-30. http://doi: 10.1016/S2215-0366(14)00079-0.

Cameron A.C. & Trivedi P.K., 2013 Regression Analysis of Count Data, second edition. Cambridge University Press, Cambridge.

Chisholm J. The Read clinical classification. (1990) *British Medical Journal* 300, 1092.

Cooper S.A., Smiley E., Morrison J., Williamson A. & Allan L. (2007) Mental ill-health in adults with intellectual disabilities: prevalence and associated factors. *British Journal of Psychiatry* **190**, 27–35.

Cooper S.A., Morrison J., Allan L.M., McConnachie A., Greenlaw N., Melville C.A., et al. (2014) Practice nurse health checks for adults with intellectual disabilities: a cluster-design randomised controlled trial. *Lancet Psychiatry* **1**, 511–21. https://doi:10.1016/S2215-0366 (14)00078-9.

Curtis L. Unit costs of health and social care 2014. 2014 Kent: Personal Social Services Research Unit. Available from https://www.pssru.ac.uk/project-pages/unit-costs/unit-costs-2014 (retrieved 9 March 2018).

Department of Health (DoH). Valuing People Now: a new three-year strategy for people with learning disabilities. Making it happen for everyone. 2009. Available from http://webarchive.nationalarchives.gov.uk/20130105064234/http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/documents/digitalasset/dh_093375.pdf (retrieved 9 March 2018)

Department of Health (DoH). National Schedule of Reference Costs - Year 2013-2014 - NHS Trusts and NHS Foundation Trusts. 2015 Department of Health, London Available from https://www.gov.uk/government/publications/nhs-reference-costs-2013-to-2014 (retrieved 9 March 2018).

Emerson E. & Baines S., 2010 Health Inequalities & People with Learning Disabilities in the UK: 2010. Improving Health & Lives: Learning Disabilities Observatory. Available from https://pure.strath.ac.uk/portal/files/7402206/vid_7479_IHaL2010_3HealthInequality2010.pdf (retrieved 9 March 2018).

Emerson E., Hatton C., Robertson J., Baines S., Christie A. & Glover G., 2013 People with Learning Disabilities in England: 2012. Durham: Improving Health & Lives: Learning Disabilities Observatory.

Franklin M., Davis S., Horspool M., Kua W.S. & Julious S. (2017) Economic Evaluations Alongside Efficient Study Designs Using Large Observational Datasets: the PLEASANT Trial Case Study. *Pharmacoeconomics* **35**, 561–73. https://doi:10.1007/s40273-016-0484-y.

Glover G. & Niggebrugge A., 2013 The uptake of health checks for adults with learning disabilities 2008/9 to 2012/13. Public Health England. Available from http://www.karentysonspage.org/20130927%20Learning%20Disability%20Health%20Checks%20Report%202012-3%20final.pdf (retrieved 9 March 2018).

Gordon L.G., Holden L., Ware R.S., Taylor M.T. & Lennox N.G. (2012) Comprehensive health assessments for adults with intellectual disability living in the community -weighing up the costs and benefits. *Australian Family Physician* **41**, 969–72.

Hatton C., Glover G., Emerson E. & Brown I., 2016 People with Learning Disabilities in England 2015: Main report. Available from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/613182/PWLDIE_2015_main_report_NB090517.pdf (retrieved 9 March 2018).

IMS Health Real World Evidence Solutions. 2016. Available from http://csdmruk.cegedim.com (retrieved 9 March 2018).

Joint Formulary Committee. British national formulary. 2013 London: Pharmaceutical Press. Available from http://www.pharmpress.com/product/MC_BNF/british-national-formulary (retrieved 9 March 2018).

de Kuijper G., Hoekstra P., Visser F., Scholte F.A., Penning C. & Evenhuis H. (2010) Use of antipsychotic drugs in individuals with intellectual disability in the Netherlands: prevalence and reasons for prescription. *Journal of Intellectual Disability Research* **54**, 659–67. https://doi: 10.1111/j.1365-2788.2010.01275.x.

The NHS Confederation (Employers) 2012. Clinical DESs for GMS contract: Guidance and audit requirements for 2012/13. Available from: https://www.nhsemployers.org/-/media/Employers/Documents/Primary-care-contracts/Enhanced-Services/2012-

13/Clinical-directed-enhanced-services-DESs-for-GMS-contract-Guidance-and-audit-requirements-for-201213.pdf (retrieved 30 July 2018).

The NHS Confederation (Employers) 2018. Available from: http://www.nhsemployers.org/-/media/Employers/Documents/Primary-care-contracts/V-and-I/2018-19-GMS-guidance.pdf (retrieved 5 October 2018).

Romeo R., Knapp M., Morrison J., Melville C., Allan L., Finlayson J. et al. (2009) Cost estimation of a health-check intervention for adults with intellectual disabilities in the UK. *Journal of Intellectual Disability Research* **53**, 426–39. http://doi: 10.1111/j.1365-2788.2009.01159.x.

Royal College of General Practitioners (RCGP). A Step by Step Guide for GP Practices: Annual health checks for people with a learning disability. 2010 Available from http://www.rcgp.org.uk/learningdisabilities (retrieved 9 March 2018).

StataCorp. Stata: Release 14. 2014. Statistical Software. College Station, TX: StataCorp LP.

Table 1. Summary of the sample

	No Annual Health Check N=102	**Annual Health Check N=106**
	Mean (SD) or N (%)	**Mean (SD) or N (%)**
Age (years)		
Mean (SD)	39.06 (16.27)	42.13 (16.32)
Gender		
Male	62 (61%)	54 (51%)
Severity of ID		
Mild	27 (26%)	15 (14%)
Mild/moderate	7 (7%)	12 (11%)
Moderate	2 (2%)	3 (3%)
Severe	-	1 (1%)
Unclear	57 (56%)	68 (64%)
Missing	9 (9%)	7 (7%)
Strategic Health Authority		
London	11 (11%)	36 (34%)
North West	2 (2%)	19 (18%)
South Central	-	7 (7%)
South East Coast	66 (65%)	14 (13%)
South West	22 (22%)	24 (23%)
West Midlands	1 (1%)	6 (6%)
Social deprivation		
1 (least deprived)	13 (13%)	13 (12%)
2	12 (12%)	20 (19%)
3	19 (19%)	30 (28%)
4	28 (27%)	19 (18%)
5 (most deprived)	30 (29%)	24 (23%)

Abbreviations: SD=standard deviation; N=number; ID=intellectual disability

Table 2. Annual Health Check routine assessments

Resources	Mean (SD) or N (%)
More than one AHC	
2 AHCs	61 (58%)
3 AHCs	14 (13%)
4 AHCs	2 (2%)
Mean routine assessments per AHC	8.83 (4.27)
Routine assessments conducted by	
Practice nurse	51 (48%)
GP	47 (44%)
Other healthcare professionals	8 (8%)
Mean number of AHC routine assessments undertaken by healthcare professionals	
Practice nurse	9.63 (4.00)
GP	9.34 (3.71)
Other healthcare professionals	4.25 (3.58)
AHC routine assessments	
Weight measurement	85 (80%)
Blood pressure measurement	84 (79%)
Alcohol status	77 (73%)
Hearing assessment	73 (69%)
Dental examination	65 (61%)
Mobility assessment	65 (61%)
Vision assessment	61 (58%)
Learning disability Health Action Plan	55 (52%)
Behaviour assessment	50 (47%)
Smoking status	49 (46%)
Other medical assessment	43 (41%)
Communication assessment	42 (40%)
Weight monitoring	39 (37%)
Laboratory tests referrals	29 (27%)
Health education	23 (22%)
Medication review	17 (16%)
Birth control	12 (11%)
Nutrition assessment	10 (9%)
Epilepsy monitoring	8 (8%)
Prescriptions	2.18 (2.50)
Prescriptions	
Central nervous system	34 (32%)
Cardiovascular system	19 (18%)
Skin disorders	14 (13%)
Respiratory system	12 (11%)
Endocrine system	11 (10%)
Gastrointestinal system	11 (10%)
Nutrition/blood	7 (7%)
Ear, Nose and Throat	7 (7%)
Obstetrics/gynaecology	6 (6%)

Notes: Routine assessments and prescriptions less than 5% are not listed.

Abbreviations: AHC=Annual Health Check; SD=standard deviation; N=number; GP=general practitioner

Table 3. Mean (±SD) resource use per person per year before and after index date

Resource use	No Annual Health Check				Annual Health Check			
	N=102				N=106			
	Before index date	After index date	Difference	p-value	Before index date	After index date	Difference	p-value
Primary care contacts								
GP (at general practice)	2.42 ± 3.89	4.00 ± 6.35	1.59	0.033	3.45 ± 3.41	4.10 ± 3.80	0.65	0.194
Practice nurse (at general practice)	0.54 ± 0.90	1.05 ± 1.88	0.51	0.015	1.45 ± 3.00	1.59 ± 2.15	0.14	0.698
Community nurses (at general practice/clinic)	0.03 ± 0.14	0.12 ± 0.32	0.08	0.018	0.05 ± 0.23	0.09 ± 0.30	0.04	0.308
GP (phone)	0.58 ± 2.64	1.11 ± 3.18	0.53	0.199	0.55 ± 1.15	1.01 ± 1.51	0.46	0.014
Practice nurse (phone)	0.28 ± 1.86	0.19 ± 0.81	-0.09	0.659	0.18 ± 0.46	0.35 ± 0.94	0.18	0.083
Community nurses (phone)	0.04 ± 0.37	0.03 ± 0.24	-0.01	0.811	0.04 ± 0.36	0.02 ± 0.12	-0.02	0.588
GP (home)	0.04 ± 0.15	0.10 ± 0.69	0.06	0.370	0.05 ± 0.20	0.15 ± 0.59	0.10	0.103
Practice nurse (home)	0.01 ± 0.05	0.003 ± 0.03	-0.003	0.655	0.01 ± 0.09	0.03 ± 0.20	0.01	0.592
Community nurses (home)	0.03 ± 0.29	0.23 ± 2.09	0.20	0.342	0.15 ± 1.56	0.03 ± 0.21	-0.12	0.433
Community and secondary care activities								
Diagnostic procedures	0.23 ± 0.64	0.43 ± 1.00	0.20	0.085	0.42 ± 0.74	0.54 ± 0.94	0.11	0.332
Laboratory tests	0.66 ± 1.21	1.06 ± 1.67	0.40	0.053	1.20 ± 1.60	1.58 ± 1.85	0.38	0.109
Non-elective admissions	0.00 ± 0.00	0.06 ± 0.25	0.06	0.018	0.01 ± 0.05	0.01 ± 0.11	0.01	0.651
Surgical procedures	0.04 ± 0.12	0.03 ± 0.10	-0.01	0.502	0.03 ± 0.17	0.04 ± 0.25	0.01	0.724
Community healthcare services contacts	0.09 ± 0.33	0.24 ± 0.69	0.15	0.044	0.15 ± 0.54	0.23 ± 0.61	0.08	0.331
Outpatient contacts	0.35 ± 1.02	0.94 ± 1.57	0.59	0.002	0.80 ± 1.22	1.95 ± 3.14	1.15	0.001
Prescriptions								
Anaesthesia	0.00 ± 0.00	0.03 ± 0.22	0.03	0.151	0.02 ± 0.12	0.01 ± 0.08	-0.004	0.799

Borderline substances	0.13 ± 1.27	0.56 ± 3.82	0.44	0.272	0.00 ± 0.00	0.07 ± 0.49	0.07	0.167
Cardiovascular system	2.55 ± 10.73	3.75 ± 11.29	1.20	0.437	11.41 ± 30.64	10.56 ± 29.35	-0.85	0.837
Central nervous system	3.55 ± 8.02	6.88 ± 17.42	3.33	0.081	16.37 ± 42.30	17.87 ± 41.31	1.49	0.795
Dental Formulary	0.00 ± 0.00	0.06 ± 0.51	0.06	0.237	0.00 ± 0.00	0.03 ± 0.32	0.03	0.319
Ear, nose and throat	0.27 ± 1.35	0.38 ± 1.55	0.11	0.591	0.24 ± 0.62	0.34 ± 0.96	0.11	0.338
Endocrine system	2.12 ± 9.85	2.87 ± 9.11	0.75	0.573	4.56 ± 13.63	4.07 ± 11.72	-0.50	0.777
Eye	0.62 ± 4.13	0.21 ± 0.85	-0.41	0.330	0.55 ± 2.58	0.45 ± 1.64	-0.10	0.737
Gastrointestinal system	0.84 ± 3.93	1.71 ± 5.04	0.87	0.173	5.22 ± 18.08	5.21 ± 16.93	-0.01	0.998
Immune system	0.01 ± 0.04	0.02 ± 0.08	0.02	0.078	0.02 ± 0.14	0.11 ± 0.33	0.09	0.013
Infections	0.53 ± 1.10	0.98 ± 3.25	0.45	0.182	1.35 ± 5.55	1.39 ± 4.96	0.05	0.950
Malignant disease	0.03 ± 0.25	0.00 ± 0.00	-0.03	0.173	0.01 ± 0.12	0.00 ± 0.00	-0.01	0.319
Muscular/ joint disease	0.30 ± 1.03	0.35 ± 0.96	0.04	0.765	1.07 ± 4.31	1.45 ± 10.33	0.38	0.730
Nutrition/ blood products	0.58 ± 4.01	0.56 ± 2.59	-0.02	0.974	0.88 ± 3.19	2.68 ± 9.44	1.80	0.064
Obstetrics/ gynaecology	0.65 ± 4.58	0.88 ± 4.39	0.23	0.712	1.48 ± 7.21	0.60 ± 2.35	-0.89	0.230
Respiratory system	1.69 ± 8.34	2.58 ± 7.24	0.89	0.416	5.15 ± 29.76	2.06 ± 6.66	-3.09	0.298
Skin disorder	0.62 ± 2.21	1.02 ± 3.00	0.39	0.289	1.77 ± 4.72	1.75 ± 3.32	-0.02	0.970
Wound management	0.95 ± 8.66	0.78 ± 6.05	-0.17	0.873	0.11 ± 0.57	0.12 ± 0.55	0.01	0.935

Abbreviations: N=number; GP=general practitioner; CI= confidence interval

Table 4. Mean (95% CI) healthcare costs per person per year before and after index date

	No Annual Health Check				Annual Health Check			
	N=102				N=106			
	Before index date	**After index date**	**Difference**	**p-value**	**Before index date**	**After index date**	**Difference**	**p-value**
Annual Health Check	----				£142.57 (£135.41 £149.74)			
Primary care contacts	£126.54 (£82.08; £170.99)	£222.97 (£154.85; £291.09)	£96.43 (£15.58; £177.29)	0.020	£191.80 (£147.01; £236.58)	£232.09 (£190.75; £273.43)	£40.29 (-£20.30; £100.89)	0.191
Community and secondary care activities	£149.16 (£87.31; £211.00)	£306.94 (£207.36; £406.53)	£157.79 (£41.27; £274.31)	0.008	£253.65 (£142.31; £364.99)	£468.05 (£189.83; £746.26)	£214.40 (-£83.53; £512.33)	0.158
Prescriptions	£204.53 (£42.20; £366.86)	£248.89 (£114.67; £383.11)	£44.34 (-£164.99; £253.73)	0.677	£485.64 (£131.98; £839.31)	£311.03 (£199.25; £422.81)	-£174.61 (-£543.37; £194.15)	0.352
Total cost	**£480.22 (£258.58; £701.86)**	**£778.81 (£531.55; £1026.07)**	**£298.59 (-£31.47; £628.64)**	**0.076**	**£931.09 (£539.18; £1323.00)**	**£1055.36 (£731.31; £1379.41)**	**£124.27 (-£381.31; £629.86)**	**0.629**

Abbreviations: N=number; CI=confidence interval

Table 5. Negative binomial regression model to examine the influence of AHC, age, gender and the total cost before index date on the healthcare costs per person with ID after index date (n=208)

	IRR	(95%CI)
Annual Health Check	1.5558	(1.1757; 2.0589)
Female	1.5504	(1.1688; 2.0566)
Age	1.0163	(1.0074; 1.0252)
Cost before index date	1.0002	(1.0001; 1.0003)

Notes: Dependent variable=total cost after the index date. Offset= exposure duration. Model=annual health check, age, gender and total cost before index date

Abbreviations: IRR=incidence rate ratio; CI=confidence interval