Healthcare cost & impact of persistent orofacial pain: DEEP Study's cohort

J.Durham[1,2], NIHR Clinician Scientist & Senior Lecturer in Oral Surgery and Orofacial Pain
J. Shen[2], Senior Research Associate in Health Economics
M. Breckons[2], Research Associate
JG Steele[1,3], Professor of Oral Health Services Research
V Araujo-Soares[3], Senior Lecturer in Health Psychology
C Exley[3], Professor of Qualitative Health Research
L Vale[2], Health Foundation Chair in Health Economics

[1]Centre for Oral Health Research & Institute of Health & Society
School of Dental Sciences
Framlington Place
Newcastle University
NE2 4BW
UK
Justin.Durham@ncl.ac.uk
Tel: +44 (0)191 208 6000
Fax: +44 (0)191 208 6137

[2]Health Economics Group
Institute of Health & Society
The Baddiley-Clark Building
Richardson Road
Newcastle upon Tyne
NE2 4AX

[3]Institute of Health & Society
The Baddiley-Clark Building
Richardson Road
Newcastle upon Tyne
NE2 4AX

Keywords: Chronic pain, Facial pain, Orofacial pain, Healthcare utilization, Cost analysis, Graded Chronic Pain Scale

Word count: 3338
References: 40
Figures: 1
Tables: 4
E-appendix with supplemental data and tables.

Funding: This study and JD are funded by a NIHR Clinician Scientist award (NIHR-CS-011-003). The views expressed in this publication are those of the author (s) and not necessarily those of the NHS, the National Institute for Health Research, or the Department of Health in the United Kingdom. The authors have no conflicts of interest to declare.

Conflicts of interest
All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare that (1) All authors have support from no commercial companies for the submitted work; (2) No authors have relationships with companies that might have an interest in the submitted work in the previous 3 years; (3) their spouses, partners, or children have no financial relationships that may be relevant to the submitted work; and (4) All authors have no non-financial interests that may be relevant to the submitted work

Abstract

Few data are available on the healthcare costs of those suffering from persistent orofacial pain (POFP). This cohort and cost analysis study examined the direct costs of POFP from the perspective of the health care provider (specifically, the UK NHS) in 2012 pounds sterling and sought to identify if dichotomised (high [IV-IIb]; low [IIa-0]) graded chronic pain scale (GCPS) status is predictive of the total cost of healthcare over the last six months. The healthcare utilisation of 198 patients with POFP were collected using a structured interview and validated “use of services and productivity” questionnaire. Unit costs were used with these utilisation data to calculate direct healthcare costs in three categories: consultation; medication; appliances and interventions. Consultation costs were a significant proportion of cumulative healthcare cost ($p<0.001$). Dichotomised GCPS status was predictive of increased healthcare cost over the last six months accounting for an average increase of £366 (95%CI: 135 - 598. $p<0.01$) when moving from a low GCPS status to a high GCPS status. Given dichotomised GCPS status’ predictive capability and the success of stratified models of care for other persistent pain conditions dichotomised GCPS status may offer an opportunity to help determine stratification of care for patients with POFP.

Perspective:

This study identifies the high demand on healthcare services from POFP patients mediated by the large number of consultations undergone and that dichotomised GCPS might help screen patients in a stratified care model and

thereby focus care and allocate healthcare resources more efficiently, irrespective of who pays the healthcare provider's costs.

Introduction

Persistent orofacial pain (POFP) is used to describe a group of heterogeneous illnesses including: Temporomandibular disorders, Burning Mouth Syndrome, Persistent Dentoalveolar Pain, Trigeminal Neuralgia, Atypical Facial pain (Persistent idiopathic facial pain) (Macfarlane et al. 2001; De Leeuw and Klasser 2013). Given POFP's nature and range of symptoms it can present to either medicine or dentistry and may need management from both (Madland and Feinmann 2001). POFP frequently becomes a chronic illness and can be difficult to manage exerting major impacts on health and quality of life (Shueb et al. 2015).

Management of chronic illnesses is subject to long-term use of healthcare services, but there are always only finite amounts of resources available to provide these services. The use of resources in one particular manner precludes their use in other desirable ways. The benefits forgone represent the opportunity cost, or economic cost, of using resources (Drummond et al. 2005). Opportunity costs can be estimated by valuing the use of services in monetary terms. Costs themselves can be directly (e.g. medication costs) or indirectly incurred (e.g. travel costs) related to healthcare. Knowledge of the costs incurred provides a baseline to consider whether changing the manner in which resources are used will be worth the benefits that might be provided; for example, changing the way POFP patients access or receive healthcare to

improve the effectiveness and efficiency of the services used and perhaps even recommend different levels of use of services (and hence cost) on the basis of predicted need. A good example of how predicted need might be established is through the use of the graded chronic pain scale (GCPS). The GCPS status and its dichotomisation has been shown to help inform the type, and extent, of therapeutic intervention required for persistent pain (Von Korff et al. 1992; Dworkin et al. 2002; Von Korff and Dunn 2008; Manfredini et al. 2013; Kotiranta et al. 2015). The dichotomisation of the GCPS may offer a screening instrument to help determine care pathways, or resource allocation, for patients.

Currently, few and limited data are available on POFP patients' healthcare costs (Glaros et al. 1995; Shimshak et al. 1997; White et al. 2001) and/or GCPS status, making it hard to predict whether potential changes in the provision of care (and hence costs) are worthwhile. As part of a larger programme of research addressing this need (DEEP study http://research.ncl.ac.uk/deepstudy (Durham et al. 2014)), this paper examines the direct costs of POFP using UK healthcare utilisation data. The study aims to identify the major components of healthcare cost and if dichotomised GCPS status (Von Korff et al. 1992; Dworkin et al. 2002) is predictive of total cost of healthcare in the last six months.

Methods

The DEEP study received ethical approval (NRES Reference: 12/YH/0338) and its methods are summarised below. An online open access protocol is also available (Durham et al. 2014).

Sample

An a priori sample size of 200 was determined (α=0.05) in order to detect, with 80% power, a moderate effect size of 0.4 (Cohen 1988) between groups using two-tailed inferential statistics. This sample size allows the use of regression analyses in order to examine up to thirty predictors of costs of managing POFP at a moderate effect size (α=0.05; β=0.8) (Green 1991). The *a priori* predictor of interest derived from the literature was dichotomised graded chronic pain status, given its prognostic validity and role in helping determine appropriate treatment regimens (Von Korff et al. 1992; Von Korff and Dunn 2008; Manfredini et al. 2013; Kotiranta et al. 2015).

To allow for a 20% attrition rate through loss to follow-up and non-response, the target was to recruit 240 individuals from primary (community) and secondary (hospital/specialist) based settings across the North-East of England (Durham et al. 2014).

To be eligible for the study individuals must:

- Have orofacial pain for three months or more
- Screen positive as having a musculoskeletal, and or neuropathic/vascular origin to their pain (Hapak et al. 1994; Gonzalez et al. 2011)

- Be over 18 years of age
- Be able to give informed consent in English.

Exclusion criteria were that an individual:

- Screened as only suffering from Dentoalveolar pain
- Had insufficient knowledge of English to be able to complete reliable consent or data collection.

Measures and instruments

Six instruments completed by participants are reported here: EQ-5D-5L for generic quality of life (Herdman et al. 2011); Graded Chronic Pain Scale (GCPS (Von Korff et al. 1992)); Multidimensional Pain inventory (MPI Version 3 (Kerns et al. 1985)); Patient Health Questionnaire 4 (PHQ-4 (Kroenke et al. 2009)); Use of services and productivity questionnaire (USPQ (Wordsworth and Thompson 2001)); Illness Perceptions Questionnaire (IPQ-R (Moss-Morris et al. 2002)). Full descriptions, scoring instructions, and interpretation guides for each instrument are provided in the e-appendix.

Dichotomised GCPS status was generated by calculating the standard five point ordinal GCPS rating (0 to IV in order of ascending disability) and applying the algorithm provided by Dworkin et al (Dworkin et al. 2002) to subdivide Grade II into II “high disability” (IIb) or II “low disability” (IIa). This algorithm converts the five point standard GCPS rating into six points and allows dichotomisation into low GCPS (grades 0-IIa) and high GCPS (grades IIb-IV) states.

Procedures and data collection

Primary care recruitment occurred from 10 dental practices and 25 medical practices, representative of all deciles of the index of multiple deprivation index (UK multifactorial deprivation measure). Secondary care recruitment occurred at specialist clinics in neurology, oral and maxillofacial surgery, dental emergency clinics, oral medicine and restorative dentistry. All recruiting centres used a standardised proforma to refer individuals to the study whom they felt would fit the appropriate inclusion criteria. Upon receipt of the proforma the research team undertook a standardised approach to screening and then recruitment (Durham et al. 2014).

Eligibility screening used validated self-complete screening questionnaires (Hapak et al. 1994; Gonzalez et al. 2011) to identify the origin of the participants' pain complaint as either musculoskeletal (sensitivity 63.1%; specificity 85.9%), neuropathic/vascular (sensitivity 66.3%; specificity 96.8%), or a combined origin if the instruments used could not definitively distinguish between origins. Individuals screening positive were invited to participate in the study, informed written consent taken, and their screening group was then used as their pain origin for the analyses. Those screening negative were thanked for their interest and took no further part in the study unless a clinical diagnosis was available from a specialist clinician that suggested this was a false negative in which case they were included and assigned a grouping in accordance with their specialist's clinical diagnosis.

Initial data collection was by trained interviewers who conducted baseline, structured interviews with questions relating to the individual's: employment; education level; duration of pain; gross monthly income; numbers and details of healthcare contacts and treatments received. The reference period for these questions was the duration of the pain complaint up to the interview. Interviewers systematically examined the individual's account of events over the duration of their complaint and recorded the data on a standardised proforma. These interview data allowed the estimation of healthcare utilisation and, in combination with healthcare unit costs, the per annum cost of the POFP condition over the duration of the complaint.

In contrast, the healthcare utilisation of the patient over the last six months were specifically examined using the USPQ and these data in combination with the healthcare unit costs allowed the calculation of the healthcare costs over the last six months. The USPQ was issued along with all other study instruments following the interview.

Data analyses

Estimation of costs

Costs of POFP to healthcare providers were grouped into three broad categories: consultation costs (visits to healthcare professional for discussion); medication costs; appliance (dental/surgical) and intervention (dental/medical/surgical) costs. All costs are at 2012 prices in pounds Sterling; the year the DEEP study started. Unit costs and sources used are detailed in

the supplemental e-appendix (Table S1, supplemental appendix), briefly described below.

All unit costs were multiplied against appropriate healthcare utilisation data either from the USPQ, to calculate the last six months costs, or data gathered in the structured interview, to calculate the total cost up to entry into the study. Per annum costs were then calculated by dividing the total cost up to entry into the study by the participant's duration of pain.

Dental primary care consultation unit costs were based on the average consultation time in primary care, the British Dental Association's standard contract for primary care and the 2012/13 dental earnings national report (HSCIC 2014). Other medical and allied health professionals' consultation unit costs in primary care were calculated using the Personal Social Services Research Unit's (PSSRU) unit costs for healthcare (2012). Secondary care consultation unit costs were identified from the NHS reference costs for the financial year 2011-2012 (DoH 2012).

Non-proprietary medication dosing regimens were multiplied against price data from the British National Formulary (Joint Formulary Committee 2012) and do not include pharmacy charges to the patient.

Primary dental care appliance and intervention unit costs were calculated using the number of units of dental activity (UDA) specified in the dental contract (NHS 2005) for the item of treatment reported multiplied by the average UDA cost (£25.61) for England and Wales in 2012 (personal communication from the British Dental Association via freedom of information request from the U.K. Department of Health in 2012). All participants paid a proportion of the burden of the total cost of the dental care with the state.

Other medical and allied health professionals' appliance and intervention unit costs were calculated using the PSSRU unit costs for healthcare (2012). Secondary care treatment unit costs were taken as the mean unit value from the appropriate NHS reference cost for the financial year 2011-2012 (DoH 2012). Secondary care dental costs for hard stabilisation and soft splints were not available in the reference costs and were obtained from a local hospital.

Statistical procedures

STATA version 13 was used for all analyses (Stata Statistical Software. StataCorp LP, College Station, TX, USA). Standard descriptive statistics were calculated. Parametric inferential statistical tests were used to examine differences in impact of pain between the dichotomised high and low GCPS groups and also in the analysis of drop-out from the study. Bootstrapping using the bias corrected accelerated method with 1000 repetitions was conducted to produce confidence intervals around the point estimate of the mean total cost and three cumulative cost categories: consultations, medication, and appliance and intervention costs. A bootstrapped one-way ANOVA was then used to examine differences between costs in the three

cumulative cost categories in line with recommended practice for cost data (Barber and Thompson 2004).

Scatter plots were used to examine outliers and crosscheck validity of data entry. Different functional forms of regression were tested (linear and log-linear), but the best performing model, as would be expected and recommended as best practice by the literature (Mihaylova et al. 2011), was a generalised gamma linear model (GLM) using an identify link function. This GLM model was used to examine the relationship between total cost over the last six months and the dichotomised GCPS status, controlling for demographic and socioeconomic factors. A modified park test was used to confirm the family for the generalised linear model.

Deterministic sensitivity analyses (DSA) were conducted on variables where there could be uncertainty over the unit costs: primary dental care consultation costs, and secondary care consultation and treatment costs. DSA used alternate higher and lower values for the unit costs in order to recalculate the total cost at its highest and lowest plausible values. In the case of those variables calculated from healthcare reference costs, the upper and lower quartile values were used as the basis for the DSA (DoH 2012). For all other variables one standard deviation, as given by the source used (e-appendix – table S1), was used to explore the range of cost for the DSA.

In the instruments used in the study there were no missing data in the GCPS or the MPI. EQ-5D-5L had five singular missing data points (0.5%) and these were imputed. PHQ-4 had missing data in 10 individuals and therefore the

summary score was incalculable. IPQ-R had 3% of data missing across all domains after imputation per domain there were five to seven participants per domain where domain scores could not be calculated (>1 missing item). Imputation procedures are explained in the e-appendix.

The present report follows the STROBE statement regarding cohort studies (von Elm et al. 2007).

Results

From a total of 387 individuals referred for eligibility screening by the participating centres (Durham et al. 2014), 279 (72%) agreed to be screened. There was no significant difference in age ($t(366)=1.24$; $p=0.215$; 95%CI difference -1.52, 6.73years) or gender ($X^2(1, n=386)=0.66$; $p=0.261$) between those declining the invitation to be screened and those who accepted the invitation.

Figure 1 demonstrates the flow of participants and dropout rates through the study following screening. The final 198 participants used for this study did not differ significantly in gender ($X^2(1, n=239)=0.20$; $p=0.658$), ethnicity ($F(6,232)=0.16$; $p=0.988$), duration ($t(237)=1.43$; $p=0.154$; 95%CI difference -12.12,76.65months) or origin of pain ($F(2,236)=2.13$; $p=0.122$) from those who dropped out. Those participating were, however, older than those who dropped out ($t(237)=3.78$; $p<0.01$; 95%CI difference 5.28,16.87years).

Females made up the majority of those recruited (81%) and the most frequent screening result for the pain's origin was musculoskeletal (43%, Table 1). The majority of the sample were in employment (59%, Table 1) with the mean monthly gross salary being £940 (±1018 s.d.). Table S2 details the pain's history and impact demonstrating that the participants had a variable duration of pain with a mean duration of 108.4 (±130.3 s.d.) months and over this period they had consulted on average 4 healthcare professionals (±2 s.d.) in

relation to their complaint with most (93%) having experienced at least one treatment for their pain.

Table 2 demonstrates healthcare costs since the complaint began with a significant difference evident between consultation, medication, and appliance and intervention costs. Consultation costs were significantly higher than both of the other two cost categories in both the per annum ($F(2,591)=71.08$ $P<0.001$) and last six month's ($F(2,591)=70.30$; $P<0.001$) costs and therefore accounted for the largest proportion of the cumulative healthcare cost.

The deterministic sensitivity analyses, which varied the unit costs to account for uncertainties over the costs of some variables, suggests that the lowest plausible total mean cost per annum is £292 (95%CI: 239 - 345) and the highest is £473 (95%CI: 383 - 563). Similarly the lowest plausible total mean cost over the last six months is £544 (95%CI: 455 - 634) and the highest is £766 (95%CI: 607 - 925).

Due to missing data in some of the sociodemographic variables, the sample size used in the GLM regression model was 175. The model's results, (Table 3), demonstrate that dichotomised GCPS is a statistically significant predictor of the total pain management costs over the last 6 months, controlling for age, gender, origin of pain, duration of pain, employment status, level of education,

and index of multiple deprivation. Moving from a low to a high GCPS status increased cost by £366 (95%CI: 135 - 598. $p<0.01$). Costs in each cost category along with sociodemographic and economic status are also broken down by dichotomised GCPS status in the e-appendix (Tables S3 & S4).

The high GCPS state (IIb-IV) produces significantly more biopsychosocial impact than the low state as measured by the MPI, PHQ-4 and EQ-5D-5L (Table 4). There were few differences in illness perceptions between those in the two states.

Discussion

Consultation costs were identified as the major driver of total healthcare utilisation costs in POFP and therefore also represent the main use of health services. The dichotomised GCPS state was identified as a good predictor of the total cost of healthcare utilisation and the high GCPS state was associated with significantly more biopsychosocial impact than the low GCPS state. Taking these two facts into consideration the dichotomised GCPS status may be used as a tool to better allocate resources. As the GCPS is applicable and valid to all healthcare communities around the world this finding is applicable to any healthcare system, state-funded or private. In all healthcare systems resources are finite and there is a desire to see resource used to the patient's best advantage. The dichotomised GCPS may help determine stratified care pathways similar to those employed with great success in other persistent pain conditions (Hill et al. 2011), which would address the call for such a system recently issued by a qualitative examination of POFP care (Peters et al. 2015).

There are several ways such a stratified model might work but one worth investigating might use a hub (specialist care centre) and spoke (community non-specialist screening and treatment centre) model and be initiated at the spoke by establishing dichotomised GCPS at first presentation. High GCPS status at first presentation would result in immediate expedited care from the hub as opposed to low GCPS, which would result in immediate care from the spoke. This putative system would offer the opportunity to rationalise

healthcare use, by focusing care on where it can be most useful. This may also help decrease the chances of further significant biopsychosocial impacts, and neuroplastic changes, especially in patients with higher-levels of pain related-disability, given that the optimisation of resources and the use of a full range of allied-health care professionals is likely to decrease waiting times. The use of this type of system might also help reduce the monetary and time costs in healthcare systems where large travelling distances exist between community and specialist settings.

There are limitations to this study. Despite the wide sociodemographic range of the sample the cohort examined may not be representative of other populations. Dropout may have resulted in selection biases of differing types. Data may be subject to recall bias due to the time period of recall for individual's use of healthcare. Recall bias and the differing modes of identifying healthcare use (interview versus questionnaire) may account for the higher healthcare costs over the last six months when compared to the per annum costs; for the former, some individuals were recalling utilisation over several years. Uncertainty around the 'true' unit costs of care also may mean that final total cost figures are subject to variation. Nevertheless we explored this in extensive sensitivity analyses and the conclusions from these analyses remain the same as the main analysis.

This study provides quantitative corroboration of previous qualitative research data that suggest the healthcare pathway for POFP is complex and potentially ‘consultation heavy’ (Durham et al. 2011; Durham and Nixdorf 2014; Peters et al. 2015). The data presented can be interpreted as either that people with POFP may have a protracted search themselves to find a cure, better pain management, or a diagnosis (Aggarwal et al. 2008; Durham et al. 2011; Peters et al. 2015). Or, that people with POFP have been given a diagnosis and management, but continue to exhibit further demand for treatment due to psychosocial co-morbidities and hence to continue to receive consultations (Barsky et al. 2001; Aggarwal et al. 2006). Whilst generic evidence exists that levels of somatization help predict healthcare use (Barsky et al. 2001) the evidence base for this in POFP is equivocal (Macfarlane et al. 1999). Given the qualitative data from published studies in the literature (Aggarwal et al. 2008; Durham et al. 2011; Peters et al. 2015) and from the DEEP study itself (unpublished as yet) it is potentially more likely that some of the disparity between cost categories may be due to a lack of “ownership” of these patients; with patients falling between the two silos of dentistry and medicine. This leaves those affected without a defined care pathway and without a defined point of entry for more tailored and specific diagnosis and management. One way of preventing this would be to create a defined point of entry for anyone with orofacial pain persisting over three months at the spokes of the hub and spoke model. Using the dichotomised GCPS status to stratify care at first presentation to the spokes would help decrease the number of consultations which were the major driver of cost in this study, but

the question of whether allocation of *more* resource to one particular group of patients would be beneficial still remains to be answered. Answers to this question may be identified in the economic modelling of longitudinal data from the ongoing DEEP study.

Statements

Acknowledgements

We would like to thank the patients and health professionals who participated in this study and made it possible. Finally, we would like to thank the steering group members who have given very valuable advice at differing stages of the ongoing study. The authors declare no conflict of interest.

Details of contribution

JD - Performed the primary analysis of data and had substantial contributions to the conception and design of the work, interpretation of the data, drafting and revising the work and final approval of the work.

JS – Substantial contributions to the analysis and interpretation of the data, drafting and revising the work, and final approval of the work.

MB - Substantial contributions to the acquisition, analysis and, interpretation of the data, drafting and revising the work, and final approval of the work.

VAS, JGS, CE - substantial contributions to the conception and design of the work, interpretation of the data, drafting and revising the work, and final approval of the work.

LV - substantial contributions to the conception and design of the work, analysis and interpretation of the data, drafting and revising the work and final approval of the work.

References

Aggarwal, VR, McBeth, J, Zakrzewska, JM, Lunt, M, Macfarlane, GJ. 2006. The epidemiology of chronic syndromes that are frequently unexplained: do they have common associated factors? Int. J. Epidemiol. 35(2):468–476.

Aggarwal, VR, McBeth, J, Zakrzewska, JM, Macfarlane, GJ. 2008. Unexplained orofacial pain - is an early diagnosis possible? Br Dent J 205(3):E6; discussion 140–1.

Barber, J, Thompson, S. 2004. Multiple regression of cost data: use of generalised linear models. J Health Serv Res Policy 9(4):197–204.

Barsky, AJ, Ettner, SL, Horsky, J, Bates, DW. 2001. Resource utilization of patients with hypochondriacal health anxiety and somatization. Med. Care 39(7):705–715.

Cohen, J. 1988. Statistical power analysis for the behavioral sciences (2nd ed.). New Jersey: Lawrence Erlbaum.

De Leeuw, R, Klasser, GD. 2013. Orofacial pain: guidelines for assessment, diagnosis, and management. Hanover Park, IL: Quintessence.

DoH. 2012. NHS reference costs: financial year 2011 to 2012.

Drummond, MF, Sculpher, MJ, Torrance, GW, O'Brien, BJ, Stoddart, GL. 2005. Methods for the economic evaluation of health care programmes. New York, USA: Oxford University Press.

Durham, J, Breckons, M, Araujo-Soares, V, Exley, C, Steele, J, Vale, L. 2014. Developing Effective and Efficient care pathways in chronic Pain: DEEP study protocol. BMC Oral Health 146.

Durham, J, Nixdorf, DR. 2014. Healthcare pathway and biopsychosocial impact of persistent dentoalveolar pain disorder: a qualitative study. Int Endod J 47(12):1151–1159.

Durham, J, Steele, J, Moufti, MA, Wassell, R, Robinson, P, Exley, C. 2011. Temporomandibular disorder patients' journey through care. Community Dent Oral Epidemiol 39(6):532–541.

Dworkin, SF, Huggins, KH, Wilson, L, Mancl, L, Turner, J, Massoth, D, LeResche, L, Truelove, E. 2002. A randomized clinical trial using research diagnostic criteria for temporomandibular disorders-axis II to target clinic cases for a tailored self-care TMD treatment program. J Orofac Pain 16(1):48–63.

Glaros, AG, Glass, EG, Hayden, WJ. 1995. History of treatment received by patients with TMD: a preliminary investigation. J Orofac Pain 9(2):147–151.

Gonzalez, YM, Schiffman, E, Gordon, SM, Seago, B, Truelove, EL, Slade, G, Ohrbach, R. 2011. Development of a brief and effective temporomandibular disorder pain screening questionnaire: reliability and validity. J. Am. Dent. Assoc. 142(10):1183–1191.

Green, SB. 1991. How many subjects does it take to do a regression analysis. Multivariate behavioral research 26(3):499–510.

Hapak, L, Gordon, A, Locker, D, Shandling, M, Mock, D, Tenenbaum, HC. 1994. Differentiation between musculoligamentous, dentoalveolar, and neurologically based craniofacial pain with a diagnostic questionnaire. J Orofac Pain 8(4):357–368.

Herdman, M, Gudex, C, Lloyd, A, Janssen, M, Kind, P, Parkin, D, Bonsel, G, Badia, X. 2011. Development and preliminary testing of the new five-level version of EQ-5D (EQ-5D-5L). Quality of Life Research 20(10):1727–1736.

Hill, JC, Whitehurst, DG, Lewis, M, Bryan, S, Dunn, KM, Foster, NE, Konstantinou, K, Main, CJ, Mason, E, Somerville, S et al. 2011. Comparison of stratified primary care management for low back pain with current best practice (STarT Back): a randomised controlled trial. Lancet 378(9802):1560–1571.

HSCIC. 2014. Dental earnings and expenses 2012/13 initial analysis.

Joint Formulary Committee. 2012. British National Formulary. London: BMJ Group and Pharmaceutical Press.

Kerns, RD, Turk, DC, Rudy, TE. 1985. The West Haven-Yale Multidimensional Pain Inventory (WHYMPI). Pain 23(4):345–356.

Kotiranta, U, Suvinen, T, Kauko, T, Le Bell, Y, Kemppainen, P, Suni, J, Forssell, H. 2015. Subtyping patients with temporomandibular disorders in a primary health care setting on the basis of the research diagnostic criteria for temporomandibular disorders axis II pain-related disability: a step toward tailored treatment planning? J Oral Facial Pain Headache 29(2):126–134.

Kroenke, K, Spitzer, RL, Williams, JB, Lowe, B. 2009. An ultra-brief screening scale for anxiety and depression: the PHQ-4. Psychosomatics 50(6):613–621.

Macfarlane, GJ, Morris, S, Hunt, IM, Benjamin, S, McBeth, J, Papageorgiou, AC, Silman, AJ. 1999. Chronic widespread pain in the community: the influence of psychological symptoms and mental disorder on healthcare seeking behavior. J. Rheumatol. 26(2):413–419.

Macfarlane, TV, Glenny, AM, Worthington, HV. 2001. Systematic review of population-based epidemiological studies of oro-facial pain. J Dent 29(7):451–467.

Madland, G, Feinmann, C. 2001. Chronic facial pain: a multidisciplinary problem. J Neurol Neurosurg Psychiatry 71(6):716–719.

Manfredini, D, Favero, L, Gregorini, G, Cocilovo, F, Guarda-Nardini, L. 2013. Natural course of temporomandibular disorders with low pain-related impairment: a 2-to-3-year follow-up study. J Oral Rehabil 40(6):436–442.

Mihaylova, B, Briggs, A, O'Hagan, A, Thompson, SG. 2011. Review of statistical methods for analysing healthcare resources and costs. Health Econ 20(8):897–916.

Moss-Morris, R, Weinman, J, Petrie, KJ, Horne, R, Cameron, LD, Buick, D. 2002. The revised illness perception questionnaire (IPQ-R). Psychology & Health 17(1):1–16.

NHS. 2005. National Health Service (General Dental Services Contracts) Regulations.

Peters, S, Goldthorpe, J, McElroy, C, King, E, Javidi, H, Tickle, M, Aggarwal, VR. 2015. Managing chronic orofacial pain: A qualitative study of patients', doctors', and dentists' experiences. Br J Health Psychol 20(4):777–791.

Shemilt, I, Thomas, J, Morciano, M. 2010. A web-based tool for adjusting costs to a specific target currency and price year. p. 51–59.

Shimshak, DG, Kent, RL, DeFuria, M. 1997. Medical claims profiles of subjects with temporomandibular joint disorders. Cranio 15(2):150–158.

Shueb, SS, Nixdorf, DR, John, MT, Alonso, BF, Durham, J. 2015. What is the impact of acute and chronic orofacial pain on quality of life. J Dent 43(10):1203–1210.

von Elm, E, Altman, DG, Egger, M, Pocock, SJ, Gotzsche, PC, Vandenbroucke, JP. 2007. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Ann. Intern. Med. 147(8):573–577.

Von Korff, M, Dunn, KM. 2008. Chronic pain reconsidered. Pain 138(2):267–276.

Von Korff, M, Ormel, J, Keefe, FJ, Dworkin, SF. 1992. Grading the severity of chronic pain. Pain 50(2):133–149.

White, BA, Williams, LA, Leben, JR. 2001. Health care utilization and cost among health maintenance organization members with temporomandibular disorders. J Orofac Pain 15(2):158–169.

Wordsworth, S, Thompson, S. 2001. An annotated cost questionnaire for patients: results of piloting. HERU Dicussion Paper 03/01

Table 1 – Socioeconomic and demographic characteristics of sample

Characteristic		**Screening result for origin of pain[1]**			
		MSK n=86	**NP/NV n=64**	**COMB n=48**	**Total n=198**
Age and gender					
n (%) females		68 (79.1)	53 (82.8)	39 (81.2)	160 (80.9)
Age (Mean[+/-SD])/yrs		52.9 (±16.7)	50.4 (±15)	51.9 (±16.1)	51.8 (±16)
n (%) Ethnic origin					
White British		77 (89.5)	38 (59.4)	43 (89.6)	158 (79.8)
White - any other white background		0(0)	0 (0)	1(2.1)	1 (0.5)
Black or Black British - African		1(1.2)	0 (0)	0(0)	1 (0.5)
Other - Chinese		0(0)	1 (1.6)	0(0)	1 (0.5)
Other - Not known		0(0)	4 (6.2)	0(0)	4 (2)
Undeclared		1(1.2)	5 (7.8)	1(2.1)	7 (3.5)
Missing data		7(8.1)	16 (25)	3(6.2)	26 (13.1)
Socioeconomic status					
n (%) Highest educational level					
	University - Postgraduate degree or diploma	8 (9.3)	11 (17.2)	3 (6.2)	22 (11.1)
	University - Undergraduate degree or diploma	23 (26.7)	18 (28.1)	13 (27.1)	54 (27.3)
	Vocational qualifications	19 (22.1)	15 (23.4)	9 (18.8)	43 (21.7)
	Secondary school public examinations -	18 (21.0)	9 (14.1)	12 (25.0)	39 (19.7)
	No public examinations	13 (15.1)	4 (6.2)	6 (12.5)	23 (11.6)
	Missing data	5 (5.8)	7 (10.9)	5 (10.4)	17 (8.6)
n (%) Index of multiple deprivation decile ranking of home postcode[a]					
	10th & 9th (Least deprived areas in UK)	14 (16.3)	7 (11.0)	8 (16.6)	29 (14.7)
	8th & 7th	16 (18.6)	11 (17.2)	12 (25.0)	39 (19.7)
	6th & 5th	13 (15.1)	13 (20.3)	5 (10.4)	31 (15.7)
	4th & 3rd	20 (23.2)	8 (12.5)	16 (33.3)	44 (22.3)
	2nd & 1st (Most deprived areas of UK)	22	25	5 (10.4)	52

Characteristic		Screening result for origin of pain[1]			
		MSK n=86	**NP/NV n=64**	**COMB n=48**	**Total n=198**
		(25.6)	(39.1)		(26.2)
	Missing data	1 (1.2)	0 (0)	2 (4.2)	3 (1.5)
n (%) employed[b]		53 (61.6)	42 (65.6)	21 (43.8)	116 (58.6)
	Groups 1 - 3	22 (25.7)	27 (42.2)	10 (20.9)	59 (29.8)
	Groups 4 - 6	20 (23.3)	13 (20.4)	6 (12.5)	39 (19.6)
	Groups 7 - 9	11 (12.8)	2 (3.2)	5 (10.4)	18 (9.0)
n (%) unemployed		7 (8.1)	9 (14.1)	11 (22.9)	27 (13.6)
n (%) retired		21 (24.4)	9 (14.1)	14 (29.2)	44 (22.2)
n (%) sick leave because of POFP		0(0)	1 (1.6)	1(2.1)	2 (1)
n (%) student		3(3.5)	2 (3.1)	0(0)	5 (2.5)
n (%) missing data		2(1.2)	1 (1.6)	1(2.1)	4 (2.0)

[1]*MSK - Musculoskeletal; NP/NV - Neuropathic/vascular; COMB - Combined origin derived from screening questionnaires used at entry to study* (Hapak et al. 1994; Gonzalez et al. 2011)

[a]*Index of multiple deprivation (IMD) rank is calculated using the 2010 English census data which defined 32482 small geographic areas in England . Each of these areas was assessed on 38 domains and scored according to standardised criteria. Each area was then ranked from the best score (rank 1) to the worst (32482) according to IMD score. http://neighbourhood.statistics.gov.uk/dissemination/*

[b]*Major group occupational categories from UK Office for National Statistics SOC 2010: Group 1 - Managers, directors & senior officials; Group 2 - Professional occupations; Group 3 - Associate professional & technical occupations; Group 4 - Administrative & secretarial occupations; Group 5 - Skilled trades occupations; Group 6 - Caring, leisure & other service occupations; Group 7 - Sales and customer service occupations; Group 8 - Process, plant & machine operatives; Group 9 - Elementary occupations*

POFP – Persistent Orofacial Pain

Table 2 – Healthcare utilisation costs since complaint began

Cost category		Total cost since complaint began/£*	Per annum cost over duration complaint/ £*	Most recent 6 months costs/£*
Mean consultation costs				
	Primary medical care	444	106	194
	Primary dental care	70	17	23
	Physiotherapy	8	5	40
	Secondary specialist care	732	147	321
	Total (Bootstrapped confidence interval[a])	1318 (1034;1601)	285 (237;333)	538 (424;653)
Mean medication costs by class of drug				
	Simple analgesia (Paracetamol, NSAIDs)	2	1	2
	Opioids	3	1	2
	Antidepressants (TCA, SSRI, SNRI)	5	1	9
	Antiepileptics	22	7	21
	Migraine abortives and prophylactics (excluding antiepileptics)	9	1	3
	Topical therapy	0	0	0
	Anxiolytics	0	0	0
	Total (Bootstrapped confidence interval [a])	41 (31; 51)	10 (6;14)	38 (21;54)
Mean appliance and intervention costs				
	Primary dental care	29	13	64
	Secondary specialist care	321	54	2
	Total (Bootstrapped confidence interval [a])	428 (213;642)	80 (41;118)	66 (50;82)
Overall total mean cost (Bootstrapped confidence interval [a])		1751 (1314;2189)	362 (291;433)	642 (525;758)

[a]*Bootstrapped confidence intervals of the total cost using a bias corrected accelerated technique and 1000 repetitions*

**Currency is pounds sterling at 2012 prices, but can be converted to other national currencies using the validated Campbell and Cochrane Economics Methods Group (CCEMG) and Evidence for Policy and Practice Information and Coordinating Centre's (EPPI-centre) Cost Converter* (Shemilt et al. 2010) *available at http://eppi.ioe.ac.uk/costconversion/ (last accessed 8th March 2016)*

NSAIDS – Non Steroidal Anti-Inflammatory Drugs; TCA – Tricyclic antidepressants; SSRI – Selective Serotonin Reuptake Inhibitors; SNRI – Serotonin and Noradrenaline Reuptake Inhibitor

Table 3 – Single predictor generalised gamma linear regression model (identity link function) adjusted for socioeconomic status and duration of pain

Variable	Coefficient[a]	95% Confidence Interval	
Dichotomised GCPS state (Low [0-IIa]; High [IIb-IV])	366**	135	598
Age group (Reference category: 20-29)			
30-39	125	-350	601
40-49	102	-249	452
50-59	-33	-412	347
60-69	-173	-521	174
70-79	-2	-543	539
80-89	490	-171	1150
Male (Reference category: female)	122	-118	361
Duration of pain (Reference category: <1year)			
1-4 years	86	-85	257
≥5years	129	-109	367
Origin of pain (Reference category: musculoskeletal origin)			
Neuropathic/vascular	-241**	-413	-70
Combined	67	-161	295
Dichotomised IMD score (Reference category: bottom 50%)	38	-125	200
Education (Reference category: degree level education or higher)			
No public exams	227**	59	395
Secondary exams	121	-24	265
Economic activity (Reference category: "other" including unemployed, sick, and students)			
Employed	-150	-466	167
Retired	-104	-480	273
Constant	452*	95	809

GCPS – graded chronic pain scale; IMD – Index of multiple deprivation
**p<0.01; *p<0.05

[a] – Coefficient is pounds sterling at 2012 prices. Interpretation example: those with no public exams compared to those with a degree level education cost, on average, £227 more for their health utilisation holding all other variables constant. Prices can be converted to other national currencies using the validated Campbell and Cochrane Economics Methods Group (CCEMG) and Evidence for Policy and Practice Information and Coordinating Centre's (EPPI-centre) Cost Converter (Shemilt et al. 2010) available at http://eppi.ioe.ac.uk/costconversion/ (last accessed 8th March 2016)

Table 4 - Psychosocial impact of pain by dichotomised GCPS state

Instrument	**Domain**	**Low GCPS (0-IIa) n=121**		**High GCPS (IIb-IV) n=77**	
		Mean score	95% CI	Mean score	95% CI
MPI					
Pain impact subscales	Pain severity	38.43	35.54; 41.32	54.17***	50.02; 58.31
	Interference	35.4	32.75; 38.04	52.29***	50.19; 54.40
	Life control	65.85	62.26; 69.44	52.83***	48.91; 56.74
	Affective distress	44.77	42.01; 47.53	54.95***	51.76; 58.15
	Support	48.9	43.63; 54.18	60.86*	54.50; 67.23
Spousal interactions subscale	Punishing responses	23.07	18.34; 27.81	30.59	23.87; 37.30
	Soliciting responses	52	48.26; 55.75	57.57	52.78; 62.37
	Distracting responses	45.12	40.36; 49.89	51.7	45.27; 58.12
PHQ-4 score		6.74	6.16; 7.32	8.63**	7.77; 9.49
EQ-5D-5L utility value		0.75	0.72; 0.79	0.6***	0.54; 0.65
IPQ-R domains					
	Timeline	3.56	3.42; 3.70	3.77	3.55; 3.99
	Consequences	2.55	2.38; 2.73	3.59***	3.37; 3.81
	Personal Control	2.96	2.81; 3.12	3.07	2.90; 3.25
	Treatment control	3.15	2.99; 3.30	2.94	2.75; 3.12
	Illness coherence	3.29	3.08; 3.49	3.18	2.92; 3.45
	Timeline cyclical	3.52	3.35; 3.68	3.57	3.35; 3.79
	Emotional representations	2.95	2.74; 3.15	3.64***	3.42; 3.86

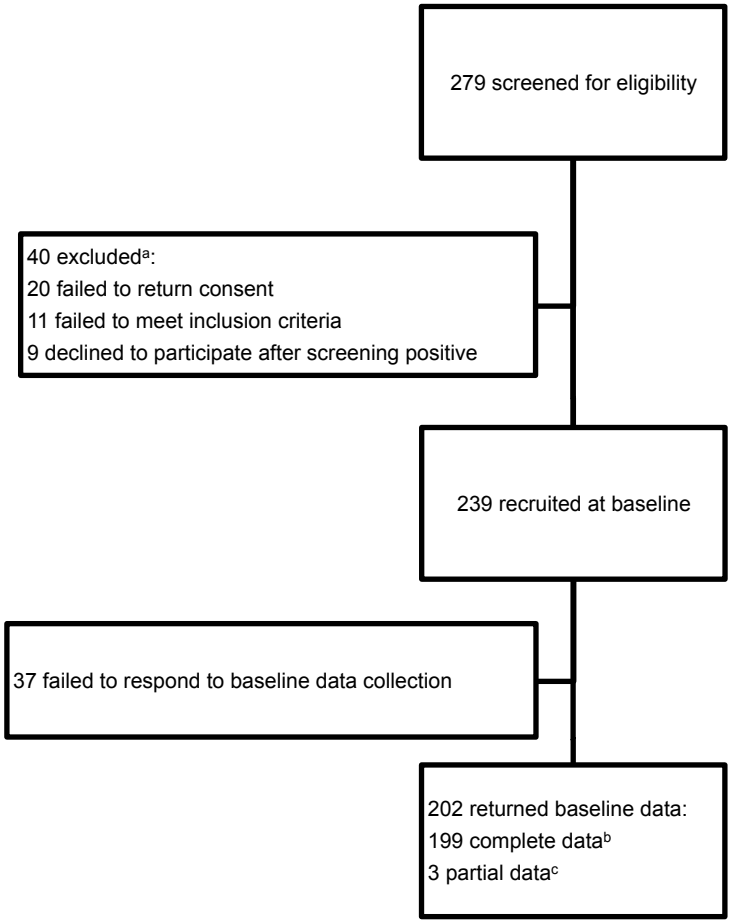
** p<0.01 two tailed unpaired t-test between low and high GCPS status*

***p<0.001 two tailed unpaired t-test between low and high GCPS status*

**** p<0.0001 two tailed unpaired t-test between low and high GCPS status*

GCPS – Graded chronic pain scale; MPI – West Haven Yale Multidimensional Pain Inventory; IPQ-R – Illness Perceptions Questionnaire Revised form

Figure 1 – Study flow diagram



[a] *No significant difference in age, gender, or origin of pain between those screening positive who agreed to participate and those who declined involvement, (p>0.05).*

[b] *One individual withdrew their data from the study at eighteen month data collection because of disagreement with the questionnaires. This left 198 complete datasets for analysis*

[c] *Three individuals stated that they had returned baseline but no data was received and they were unwilling to re-complete baseline data collection and although they continue on with the study longitudinally their baseline data is unavailable for this paper.*

Supplemental appendix

Supplemental information on instruments employed

EQ-5D-5L

EQ-5D-5L is a generic health-related preference-based instrument, which examines problems in five domains: mobility, self-care, usual activities, pain/discomfort, anxiety/depression. In EQ-5D-5L participants are asked to score the problems experienced in each domain on a five point scale from 1 (no interference or limitation) to 5 (maximum interference or limitation). The five responses are used to create an index ranging from 11111 (best possible health state) to 55555 (worst possible health state). The index is converted into a score using a scoring algorithm based on responses for the UK population. This score ranges from -0.59 (55555, which is judged to be worse than death by the general population), through 0 (death), up to a maximum of 1 (perfect health). At the time of writing normative data are only available for EQ-5D-3L, another version of the EQ-5D instrument but these data can be crosswalked to the EQ-5D 5L (van Hout et al. 2012). It is anticipated that UK population data will be available by the end of the project for the EQ-5D 5L. Recommendations for imputation of missing EQ-5D data are given by Simons et al using multiple imputation (Simons et al. 2014) at the domain level and then calculating the utility score.

Graded Chronic Pain Scale (GCPS)

The GCPS is a measure of pain-related disability and intensity with normative data for population samples available (Elliott et al. 1999). It has seven items, six of which use numerical rating scales (0-10). Three of these six items examine average, worst, and current, pain intensity. The other three items

examine the individual's level of disability in usual, daily, and recreational/social activities. These two groups of three items are both summed in their groups, then a mean taken of the individual's scores and this mean multiplied by ten to generate a characteristic pain intensity (CPI) and a disability score respectively with higher scores indicating more pain or disability.

The seventh item in the GCPS examines the number of days individuals have been prevented from their work, school or household activities in the last six months offering four predefined ranges for the respondent to chose from ("disability days"). An algorithm is provided to convert disability days, disability score, into disability points and then combine this with CPI to give a five point GCPS rating ranging from 0 to IV in order of ascending disability: 0 – no pain in past six months, to IV – High disability severely limiting. It is not possible to impute missing data on the GCPS individuals with missing data were therefore excluded from any analysis involving GCPS.

Multidimensional Pain Inventory (MPI)

The MPI is a multidimensional pain measure. Version 3 of the MPI was used as it generates scores using a Rasch modelling approach which is arguably the most robust of the three versions. Only two of the three subscales of MPI are employed in this study, the pain impact and spousal interaction subscales. The third subscale examining interference in daily activity was omitted to decrease respondent burden in line with IMMPACT recommendations (Dworkin et al. 2005) as it covered similar constructs to those provided by GCPS and the EQ-5D-5L. The internal consistency (Cronbach alpha) of the subscales in this study were comparable to, or better than, those in previous

research using this instrument *in toto* (Kerns et al. 1985; Bergström et al. 1999; Andreu et al. 2006):

Table – Internal consistency (Cronbach's alpha) of MPI subscales used in this study and those from: Kerns et al. 1985; Bergström et al. 1999; Andreu et al. 2006

	Internal consistency (Cronbach's alpha of subscale)			
MPI Sub-scale	Current study	Kerns et al '85[1]	Bergstrom et al 99[2]	Andreu et al 06[3]
Pain severity	0.79	0.72	0.80	0.75
Interference	0.93	0.90	0.86	0.85
Life control	0.83	0.79	0.66	-
Affective distress	0.72	0.73	0.80	0.75
Support	0.90	0.83	0.81	0.82
Punishing responses	0.91	0.84	0.86	0.78
Soliciting responses	0.83	0.78	0.77	0.85
Distracting responses	0.76	0.74	0.76	-

1 Population sample of all types of chronic pain from hospital pain clinic n=120
2 Population sample of chronic musculoskeletal pain (non-specific back or neck) from hospital rehabilitation clinics n=682
3 Population sample Research Diagnostic Criteria (RDC/TMD) diagnosed TMD patients from specialist hospital clinic n=114. Life control and Distracting responses subscales data not given in paper

All items in the MPI are rated either zero to six, or zero to four. Using MPI software (www.pain.pitt.edu/mpi) domain scores ranging from 0 to 100 were calculated for: pain severity, interference, life control, affective distress, support, punishing responses, soliciting responses, distracting responses. Higher scores in pain severity, interference, affective distress indicate a greater impact on the individual. Higher scores in life control and support indicate greater life control or greater amounts of support. Higher scores in the three "repsonses" domains indicate greater amounts of that type of response. Rasch modelling accounts for missing data and therefore no imputation is required.

Use of services and productivity questionnaire

The use of services and productivity questionnaire (USPQ) used in this study was adapted from that proposed by Wordsworth and Thompson as a generic template for use of services and productivity questionnaires ((Wordsworth and Thompson 2001) available at http://www.dirum.org/instruments/details/28).

The self-complete USPQ used in this study contained three sections that specifically examined costs encountered in the preceding six month period in relation to: consultations, medication and treatment, and productivity losses. Although indirect costs incurred by the patient were examined in the questionnaire the focus for this study is on the health care provider perspective and examples of the types of questions identifying healthcare utilisation from the perspective of the healthcare provider in the two sections relevant to this study (consultations, medication and treatment) are provided in brief below so that readers can comprehend how data were obtained on healthcare utilisation. The full version of the original USPQ is freely available at the website above.

Consultations' section

The consultations' section contained several questions in the form as below with X substituted for a range of healthcare providers (general medical practitioner, general dental practitioner, dental hospital specialist or consultant, medical hospital specialist or consultant, physiotherapist, psychologist, and other healthcare professional) to identify whether participants had seen particular healthcare professionals in the last six months in relation to their POFP and if so how many times they had seen them:

Have you seen **X**?

Yes ☐ No (move to question Y.Y) ☐

If yes, did you see them as an NHS patient? Yes ☐ No ☐

How many times did you see the X? ☐☐☐

If you had to pay anything for your appointments, how much have you paid in total over the last six months? £☐☐☐-☐☐p

Medications and treatment section

This section contained several questions related to whether participants had used specific groups of medications for their POFP including NSAIDs, opiates, Tricyclic Antidepressants, Antiepileptics, and "Other" medications, in the last six months. Drug classes were given in lay terminology along with specific examples of the types of drug that these classes would include in order to help remind people of the type of drugs in this group. The standard advice for the entire study was that if participants were in doubt when completing a question they could contact the research team or place a comment by the question and the research team would follow-up with them. An example of one of the medication questions is below:

> In the last six months, which of the following medications have been **prescribed** by your doctor/dentist (including tablets, capsules, inhalers, injections, creams, lotions and mixtures) to be used to **manage your pain in your mouth and or face***?* You may chose more than one medication and for each medication chosen please give details of the medication's total daily dose (the total amount in milligrams of the tablets you take per day) and whether you have used this medication regularly through each day or only when needed.
>
> You may find it helpful to look on the packaging of your medication to check its details. Please check the box (☒) against the groups you are using and give further details on those groups as indicated. If you are using none of the prescribed medications listed below in a-f please check this box ☐ and go to question 2.4.
>
> **a) Anti-inflammatory painkillers** ☐
> For example: Naproxen, Diclofenac (also known as Voltarol), Ibuprofen
>
> Please give name(s) of drug(s):_____
> Please indicate **total daily** dose ☐☐☐☐ milligrams (mg)
> Used regularly ☐ or as needed ☐

Following the questions on medications participants were asked about any dental, medical, or surgical interventions they had experienced in the last six months in an attempt to address their POFP. Again a number of common interventions were specified along with an “other” category. Patients were asked to indicate if they had undergone the specified intervention and if it was provided by the NHS or by a private healthcare provider and if the latter how much they paid for it.

There was also a final section in the questionnaire where participants could add in free-text any additional items they felt hadn’t been covered by the structured questions previously. The research team followed up any comments placed in this section that suggested costs that hadn’t been accounted for in the earlier sections of the questionnaire with the participant by telephone.

Illness perceptions questionnaire (IPQ-R)

The shortened version of the IPQ-R (http://www.uib.no/ipq/index.html) (Moss-Morris et al. 2002), validated by Sniehotta et al (Sniehotta et al. 2010) , was used. This version consists of twenty-one items, which employ a five-point response scale: strongly disagree (1) to strongly agree (5). Appropriate items are summed in order to calculate seven domain scores: timeline; consequences; personal control; treatment control; illness coherence; timeline cyclical; emotional representations. With the exception of the personal and treatment control domains, higher domain scores represent less adaptive illness perceptions. Higher scores in the personal and treatment control

domains represent more adaptive illness perceptions. Imputation guidelines (http://www.uib.no/ipq/index.html) state that up to one item missing per domain can be imputed using mean imputation based on responses for the other items in that domain. More than one item with missing data in each domain renders that domain's score incalculable. There is no cumulative score for the questionnaire.

Patient Health Questionnaire 4 (PHQ-4)

The PHQ-4 is an ultra-brief screening instrument for anxiety and depression (Kroenke et al. 2009). It consists of two items from GAD-7 instrument (Spitzer et al. 2006) that screen for anxiety and two items from PHQ-9 instrument (Kroenke and Spitzer 2002) that screen for depression. All four items in PHQ-4 are problem-based and use a four-point response scale ranging from: not all (0) to nearly every day (3).

The item response codes are summed in their pairs in order to examine anxiety and depression: ≥3 is a "yellow flag" and ≥5 is a "red flag" for the relevant construct being examined (Kroenke et al. 2003; Lowe et al. 2005; Kroenke et al. 2007; Lowe et al. 2010). A cumulative score is then generated by summing all items' response codes. Guidance for the thresholds of the cumulative score are that ≥6 is a "yellow flag" and ≥9 is a "red flag" for anxiety or depression (Lowe et al. 2010). Given the small number of items in the instrument imputation is not possible and therefore if missing data were present in one domain both that domain and the cumulative score were incalculable.

Supplemental tables

Table S1 – Unit costs and sources

Cost category	Unit cost*	Source and calculation
NHS Consultation costs		
Primary care		
General medical practitioner	£62.90	Personal Social Services Research Unit's (PSSRU) unit costs for healthcare (2012)
General dental practitioner	£17.50	Combination of data on the average consultation time in primary care (10.8minutes[±4.1] (Brocklehurst and Tickle 2011)), the British Dental Association's standard contract for primary care (46 weeks per annum, working a 35 hour week) and the 2012/13 dental earnings and expenses report from the Health and Social Care Information Centre [HSCIC] ((HSCIC 2014); Average gross income £156,100) [((156200/46)/35)/60 = £1.62/minute of consultation]. Sensitivity analysis involved using the standard deviation of time per consultation to create upper and lower bounds
Secondary care		
Oral Surgery new patient	£123.00	Appropriate NHS mean reference cost for the financial year 2011-2012 (DoH 2012). Sensitivity analysis involved using the upper and lower bounds of the interquartile ranges
Oral Surgery review patient	£92.00	
Restorative dentistry new patient	£108.00	
Restorative dentistry review patient	£108.00	
Oral and Maxillofacial surgery new patient	£110.00	
Oral and Maxillofacial surgery review patient	£91.00	
Neurology new patient	£205.00	
Neurology review patient	£148.00	
Pain management new patient	£164.00	
Pain management review patient	£115.00	
Physiotherapy new patient	£49.00	
Physiotherapy review patient	£43.00	
Rheumatology new	£199.00	
Rheumatololgy review	£128.00	
Opthalmology new	£106.00	
Opthalmology review	£80.00	
ENT new	£109.00	
ENT review	£83.00	
Clinical psychology new	£89.00	
Clinical Psyhcology review	£313.00	

Liaison psychiatry new	£178.00	
Liaison psychiatry review	£208.00	
Emergency department new	£122.00	
Emergency department review	£121.00	
Medication costs		
Medication dosing regimens were combined with British National Formulary (Joint Formulary Committee 2012) price data to calculate the cost of pharmacological management. All medication costs were calculated using the non-proprietary version of the medication whenever possible. When patients could not recall, or obtain, their dosing regimen mean imputation from other users of that drug was used to impute the cost of that particular drug.		
NHS Procedure and appliance costs		
Primary dental care. Primary dental treatment costs are incorporated into the UDA value		Calculated using the number of units of dental activity (UDA) specified in the dental contract (NHS 2005) for the item of treatment reported multiplied by the average UDA cost (£25.61) for England and Wales in 2012 (BDA 2012) minus the patient contribution (NHS 2005)
Cost to NHS for band 1 dental treatment non-exempt. 1 UDA value Broad description of band: Examination, diagnosis, preventative care, x-rays, scale and polish	£8.11	Patient contribution £17.50
Cost to NHS for band 2 dental treatment non-exempt. 3 UDA value Broad description of band: Any of band 1 plus fillings, root canals, and extractions	£28.83	Patient contribution £48.00
Cost to NHS for band 3 dental treatment non-exempt. 12 UDA value Broad description of band: Any of band 1 or 2 plus crowns, bridges or dentures, or splints	£98.32	Patient contribution £209.00
Cost to NHS for Urgent dental treatment non-exempt. 1.2 UDA value. Broad description of band: Any emergency or out-of hour care.	£13.23	Patient contribution £17.50
Secondary care		
Soft splint	£57.00	Secondary care dental costs for hard stabilisation and soft splints were not available in the reference costs and were obtained from a local hospital
Stabilisation splint	£349.65	

Out-patient tooth extraction	£134.00	Taken as the mean national unit value from the appropriate NHS reference cost for the financial year 2011-2012 (DoH 2012). Sensitivity analysis involved using the upper and lower bounds of the interquartile ranges
Sinus washout	£1,082.00	
Salivary gland surgery	£3,623.00	
Temporomandibular joint surgery	£3,623.00	
Lumbar puncture	£682.00	
Microvascular decompression Trigeminal nerve	£10,084.00	
Ballon compression Trigeminal nerve	£1,396.00	

**Prices in pounds sterling at 2012 prices*

Table S2 – Pain history and impact

Pain characteristic or impact		Screening result for origin of pain[1]			
		MSK n=86	**NP/NV n=64**	**COMB n=48**	**Total n=198**
Pain history. (Mean [+/- SD])	Duration of pain/months	88.5 (±102.8)	160.9 (±173.2)	74.2 (±78.2)	108.4 (±130.3)
	Total number of visits primary care[a]	11 (±16.9)	14 (±15.4)	14.3 (±20.2)	12.7 (±17.3)
	Total number visits secondary specialist care[b]	7.6 (±13.8)	6.7 (±18.8)	10 (±30.8)	7.9 (±20.6)
	Total number of healthcare providers seen	4.2 (±2.4)	2.8 (±2.2)	4 (±2.2)	3.7 (±2.3)
	Total number of treatments attempted	4.3 (±4.1)	3.7 (±2.5)	4.8 (±4.7)	4.2 (±3.8)
	Most effective treatment score (0 no effect - 10 resolved pain)	5.9 (±3.4)	7.2 (±3.2)	6.3 (±3.6)	6.3 (±3.4)
GCPS					
	Characteristic pain intensity (Mean [+/- SD])	53.3 (±20.9)	48.5 (±23.2)	67.5 (±17.5)	55.3 (±22.0)
n (%) GCPS grade	0	0 (0)	3 (4.7)	0 (0)	3 (1.5)
	1	35 (40.7)	21 (32.8)	5 (10.4)	61 (30.8)
	2a	26 (30.2)	13 (20.3)	18 (37.5)	57 (28.8)
	2b	12 (14)	12 (18.8)	11 (22.9)	35 (17.7)
	3	10 (11.6)	11 (17.2)	10 (20.8)	31 (15.7)
	4	3 (3.5)	4 (6.2)	4 (8.3)	11 (5.6)
MPI (Mean [+/-SD])					
	Pain severity	42.4 (±18.7)	42.1 (±15.4)	51.6 (±20.9)	44.6 (±18.6)
	Interference	38.9 (±16.3)	43.6 (±13.9)	45.3 (±14.4)	42 (±15.3)
	Life control	63.5 (±19.9)	60.7 (±19.3)	56 (±20.4)	60.7 (±19.9)
	Affective distress	47 (±16.1)	48.0 (±12.2)	52.9 (±18.4)	48.7 (±15.6)
	Support	53.2 (±26.7)	58.7 (±27.5)	47.5 (±35.2)	53.6 (±29.3)
	Punishing responses	23.6 (±26.9)	24.3 (±27.2)	32.6 (±29.8)	26.0 (±27.8)
	Soliciting responses	53.5 (±20.4)	57.0 (±20.8)	51.7 (±22.6)	54.1 (±21.1)
	Distracting responses	52.5 (±26.3)	40.6 (±29.7)	48.5 (±24.4)	47.7 (±27.3)
PHQ-4 score (Mean [+/-SD])		7.7 (±3.5)	6.6 (±2.9)	8.4 (±4)	7.5 (±3.5)

Pain characteristic or impact		Screening result for origin of pain[1]			
		MSK n=86	**NP/NV n=64**	**COMB n=48**	**Total n=198**
EQ-5D-5L utility value (Mean[+/-SD])		0.68 (±0.229)	0.760 (±0.188)	0.631 (±0.222)	0.694 (±0.219)
IPQ-R domain scores (Mean [+/-SD])					
	Timeline	4(±2.7)	3.7 (±0.7)	5.5 (±3.5)	3.6 (±0.9)
	Consequences	2.7 (±1.1)	3.3 (±1.0)	3.1 (±1.1)	3 (±1.1)
	Personal Control	3.1 (±0.9)	2.9 (±0.9)	3.1 (±0.8)	3.0 (±0.8)
	Treatment control	3.1 (±0.9)	3.1 (±0.8)	3.2 (±1)	3.1 (±0.8)
	Illness coherence	3.5 (±1.1)	3 (±1.2)	3.2 (±1.2)	3.3 (±1.1)
	Timeline cyclical	3.3 (±1.1)	3.8 (±0.7)	3.6 (±1)	3.5 (±0.9)
	Emotional representations	3.1 (±1.2)	3.3 (±1.1)	3.4 (±1.1)	3.2 (±1.1)

[1]*MSK - Musculoskeletal; NP/NV - Neuropathic/vascular; COMB - Combined origin derived from screening questionnaires used at entry to study* (Hapak et al. 1994; Gonzalez et al. 2011)

[a]*Primary care defined as any (general) medical or dental practitioner or any other allied health professional seen in the community (including physiotherapy)*

[b]*Secondary care defined as any specialist health professional seen within a hospital setting*

GCPS – Graded chronic pain scale; MPI – West Haven Yale Multidimensional Pain Inventory;

IPQ-R – Illness Perceptions Questionnaire Revised form

Table S3 – Mean costs by cost category and graded chronic pain status per annum and over the last six months

Cost category		Per annum costs*		Last six months costs*	
		GCPS Low	GCPS High	GCPS Low	GCPS High
Mean consultation costs					
	Primary medical care	79	145	152	259
	Primary dental care	16	18	16	34
	Physiotherapy	5	4	40	39
	Secondary specialist care	134	163	260	412
	Total	251	334	428	704
	Bootstrapped confidence intervals for total cost[a]	200;303	246;423	311;545	496;913
Mean medication costs by class of drug					
	Simple analgesia (Paracetamol, NSAIDs)	1	1	1	2
	Opioids	0	1	1	5
	Antidepressants (TCA, SSRI, SNRI)	1	1	4	17
	Antiepileptics	3	12	20	23
	Migraine abortives and prophylactics (excluding antiepileptics)	1	2	1	5
	Topical therapy	0	0	0	1
	Anxiolytics	0	0	0	0
	Total	6	16	27	54
	Bootstrapped confidence intervals for total cost[a]	3;9	8;25	10;44	24;84
Mean appliance and intervention costs					
	Primary dental care	12	15	66	61

Cost category		**Per annum costs***		**Last six months costs***	
		GCPS Low	**GCPS High**	**GCPS Low**	**GCPS High**
	Secondary specialist care	50	59	3	0
	Total	76	84	69	61
	Bootstrapped confidence intervals for total cost[a]	21;131	33;136	50;88	39;84
Overall total mean cost		316	427	524	819
Bootstrapped confidence intervals for total mean cost[a]		227;406	305;549	401;647	603;1036

[a]*Bootstrapped using a bias corrected accelerated technique and 1000 repetitions*

**Prices in pounds sterling at 2012 prices*

Table S4 – Sociodemographic and socioeconomic status by dichotomised GCPS group

Characteristic		Graded chronic pain scale (GCPS) dichotomised group	
		GCPS Low (0-IIa) n=121	**GCPS High (IIb-IV) n=77**
Age and gender			
n (%) females		97(80.2)	63(81.8)
Age (Mean[+/-SD])/yrs		53.9(±15.6)	48.7(±16.2)
n (%) Ethnic origin			
White British		98(81)	60(77.9)
White - any other white background		1(0.8)	0(0)
Black or Black British - African		1(0.8)	0(0)
Other - Chinese		0(0)	1(1.3)
Other - Not known		3(2.5)	1(1.3)
Undeclared		4(3.3)	3(3.9)
Missing data		14(11.6)	12(15.6)
Socioeconomic status			
n (%) Highest educational level			
	University - Postgraduate degree or diploma	13(10.7)	9(11.7)
	University - Undergraduate degree or diploma	33(27.3)	21(27.3)
	Vocational qualifications	30(24.8)	13(16.9)
	Secondary school public examinations - Age 18	5(4.1)	5(6.5)
	Secondary school public examinations - Age 16	14(11.6)	15(19.5)
	No public examinations	14(11.6)	9(11.7)
	Missing data	12(9.9)	5(6.5)
n (%) Index of multiple deprivation decile ranking of home postcode[a]			
	10th (Least deprived areas in UK)	5(4.1)	5(6.5)
	9th	8(6.6)	11(14.3)
	8th	13(10.7)	8(10.4)

Characteristic		Graded chronic pain scale (GCPS) dichotomised group	
		GCPS Low (0-IIa) n=121	**GCPS High (IIb-IV) n=77**
	7th	12(9.9)	6(7.8)
	6th	7(5.8)	6(7.8)
	5th	8(6.6)	10(13)
	4th	23(19)	8(10.4)
	3rd	4(3.3)	9(11.7)
	2nd	19(15.7)	9(11.7)
	1st (Most deprived areas of UK)	19(15.7)	5(6.5)
	Missing data	3(2.5)	0(0)
n (%) employed[b]		75(62)	41(53.3)
	Managers, directors & senior officials	4(3.3)	1(1.3)
	Professional occupations	27(22.3)	12(15.6)
	Associate professional & technical occupations	8(6.6)	7(9.1)
	Administrative & secretarial occupations	18(14.9)	8(10.4)
	Skilled trades occupations	3(2.5)	1(1.3)
	Caring, leisure & other service occupations	5(4.1)	4(5.2)
	Sales and customer service occupations	5(4.1)	3(3.9)
	Process, plant & machine operatives	3(2.5)	1(1.3)
	Elementary occupations	2(1.7)	4(5.2)
n (%) unemployed		11(9.1)	16(20.8)
n (%) retired		29(24)	15(19.5)
n (%) sick leave because of COFP		1(0.8)	1(1.3)
n (%) student		4(3.3)	1(1.3)
n (%) missing data		1(0.8)	3(3.9)
Pain history. (Mean [+/- SD])	Duration of pain/months	110.1(±139.6)	105.9(±115.1)
	Total number of visits primary care[c]	11(±17)	15.6(±17.5)
	Total number visits secondary specialist care[d]	6.3(±12.4)	10.4(±29.1)

Characteristic		Graded chronic pain scale (GCPS) dichotomised group	
		GCPS Low (0-IIa) n=121	**GCPS High (IIb-IV) n=77**
	Total number of healthcare providers seen	3.7(±2.5)	3.8(±2.2)
	Total number of treatments attempted	3.5(±2.7)	5.5(±5)
	Most effective treatment score (0 no effect - 10 resolved pain)	6(±3.7)	7.1(±2.7)

[a]*IMD rank is calculated using the 2010 English census data which defined 32482 small geographic areas in England . Each of these areas was assessed on 38 domains and scored according to standardised criteria. Each area was then ranked from the best score (rank 1) to the worst (32482) according to IMD score. http://neighbourhood.statistics.gov.uk/dissemination/*

[b]*Major group occupational categories from UK Office for National Statistics SOC 2010*

[c]*Primary care defined as any (general) medical or dental practitioner or any other allied health professional seen in the community (including physiotherapy)*

[d]*Secondary care defined as any specialist health professional seen within a hospital setting*

References

Andreu, Y, Galdon, MJ, Durá, E, Ferrando, M, Pascual, J, Turk, DC, Jiménez, Y, Poveda, R. 2006. An examination of the psychometric structure of the Multidimensional Pain Inventory in temporomandibular disorder patients: a confirmatory factor analysis. Head Face Med 248.

BDA. 2012. Freedom of information request from Department of Health 2012 - average UDA value for England and Wales.

Bergström, KG, Jensen, IB, Linton, SJ, Nygren, AL. 1999. A psychometric evaluation of the Swedish version of the Multidimensional Pain Inventory (MPI-S): a gender differentiated evaluation. Eur J Pain 3(3):261–273.

Brocklehurst, PR, Tickle, M. 2011. Is skill mix profitable in the current NHS dental contract in England? Br Dent J 210(7):303–308.

DoH. 2012. NHS reference costs: financial year 2011 to 2012.

Dworkin, RH, Turk, DC, Farrar, JT, Haythornthwaite, JA, Jensen, MP, Katz, NP, Kerns, RD, Stucki, G, Allen, RR, Bellamy, N. 2005. Core outcome measures for chronic pain clinical trials: IMMPACT recommendations. Pain 113(1-2):9–19.

Elliott, AM, Smith, BH, Penny, KI, Smith, WC, Chambers, WA. 1999. The epidemiology of chronic pain in the community. Lancet 354(9186):1248–1252.

Gonzalez, YM, Schiffman, E, Gordon, SM, Seago, B, Truelove, EL, Slade, G, Ohrbach, R. 2011. Development of a brief and effective temporomandibular disorder pain screening questionnaire: reliability and validity. J. Am. Dent. Assoc. 142(10):1183–1191.

Hapak, L, Gordon, A, Locker, D, Shandling, M, Mock, D, Tenenbaum, HC. 1994. Differentiation between musculoligamentous, dentoalveolar, and neurologically based craniofacial pain with a diagnostic questionnaire. J Orofac Pain 8(4):357–368.

HSCIC. 2014. Dental earnings and expenses 2012/13 initial analysis.

Joint Formulary Committee. 2012. British National Formulary. London: BMJ Group and Pharmaceutical Press.

Kerns, RD, Turk, DC, Rudy, TE. 1985. The West Haven-Yale Multidimensional Pain Inventory (WHYMPI). Pain 23(4):345–356.

Kroenke, K, Spitzer, RL, Williams, JB. 2003. The Patient Health Questionnaire-2: validity of a two-item depression screener. Med. Care 41(11):1284–1292.

Kroenke, K, Spitzer, RL, Williams, JB, Lowe, B. 2009. An ultra-brief screening scale for anxiety and depression: the PHQ-4. Psychosomatics 50(6):613–621.

Kroenke, K, Spitzer, RL, Williams, JB, Monahan, PO, Lowe, B. 2007. Anxiety disorders in primary care: prevalence, impairment, comorbidity, and detection. Ann. Intern. Med. 146(5):317–325.

Kroenke, K, Spitzer, RL. 2002. The PHQ-9: a new depression diagnostic and severity measure. Psychiatr Ann 32(9):1–7.

Lowe, B, Kroenke, K, Grafe, K. 2005. Detecting and monitoring depression with a two-item questionnaire (PHQ-2). J Psychosom Res 58(2):163–171.

Lowe, B, Wahl, I, Rose, M, Spitzer, C, Glaesmer, H, Wingenfeld, K, Schneider, A, Brahler, E. 2010. A 4-item measure of depression and anxiety: validation and standardization of the Patient Health Questionnaire-4 (PHQ-4) in the general population. J Affect Disord 122(1-2):86–95.

Moss-Morris, R, Weinman, J, Petrie, KJ, Horne, R, Cameron, LD, Buick, D. 2002. The revised illness perception questionnaire (IPQ-R). Psychology & Health 17(1):1–16.

NHS. 2005. National Health Service (General Dental Services Contracts) Regulations.

Simons, CL, Rivero-Arias, O, Yu, L-M, Simon, J. 2014. Multiple imputation to deal with missing EQ-5D-3L data: Should we impute individual domains or the actual index? Quality of Life Research 1–11.

Sniehotta, FF, Gorski, C, Araujo-Soares, V. 2010. Adoption of community-based cardiac rehabilitation programs and physical activity following phase III cardiac rehabilitation in Scotland: a prospective and predictive study. Psychol Health 25(7):839–854.

Spitzer, RL, Kroenke, K, Williams, JBW, L?we, B. 2006. A brief measure for assessing generalized anxiety disorder: the GAD-7. Archives of internal medicine 166(10):1092–1097.

van Hout, B, Janssen, MF, Feng, YS, Kohlmann, T, Busschbach, J, Golicki, D, Lloyd, A, Scalone, L, Kind, P, Pickard, AS. 2012. Interim scoring for the EQ-5D-5L: mapping the EQ-5D-5L to EQ-5D-3L value sets. Value Health 15(5):708–715.

Wordsworth, S, Thompson, S. 2001. An annotated cost questionnaire for patients: results of piloting. HERU Dicussion Paper 03/01