Factors influencing Orthodontic Treatment Outcome in South East Wales and Implications for Service Commissioning.

Aim: To determine factors that may influence orthodontic treatment outcomes undertaken in General Dental Services/Personal Dental Services in South East Wales. Design and setting: A retrospective study of a requested 20 consecutively treated cases (for the year 2014-15) provided by 26 performers in South East Wales. Method: Performer and patient information was obtained by use of a questionnaire and FP17OW forms respectively. A calibrated investigator recorded the Index of Orthodontic Treatment Need (IOTN), Peer Assessment Rating (PAR) and the Index of Complexity, Outcome and Need (ICON) on start- and end-study models for each case. Descriptive and regression analyses were undertaken to identify any predictive factors of a good treatment outcome. Results: 2 respondents completed less than 20 cases, so all of their cases were assessed. A total of 495 cases were assessed. The mean end-PAR score of 5 achieved is collectively a good occlusal outcome. Predictive factors of a good quality of occlusal outcome (end-PAR score being ≤ 5) were: dual arch treatment, use of functional with fixed appliances, treatment undertaken in non-corporate practices and treatment undertaken by registered specialists ($p<0.001$). Predictive factors for occlusal improvement (change in PAR score) were: IOTN AC, IOTN DHC (1-3 or 4-5), number of arches treated and malocclusion type ($p<0.001$). Conclusions: When renegotiating NHS orthodontic contracts, commissioning bodies should consider procurement of quality services and value for money. Dual arch fixed appliances undertaken by orthodontic specialists in non-corporate environments produced the highest quality orthodontic outcomes. Those who have the highest need for treatment according to IOTN DHC and AC benefit most in terms of improvement achieved in PAR score. With future national contract changes, a system set up to continuously monitor outcomes, should continually improve the value of NHS orthodontic care.

Keywords: Orthodontics, treatment need, outcome, performer, performance

Introduction

In the UK, National Health Service (NHS) funded orthodontic treatment is undertaken upto 16 years of age. Ideally, the patient is assessed by their General Dental Practitioner (GDP) and referred to a practitioner providing orthodontic treatment if the patient presents with an Index of Orthodontic Treatment Need (IOTN) score that has a Dental Health Component (DHC) 4-5 or DHC 3 plus an Aesthetic Component (AC) ≥ 6. Referral criteria ensures standardised entry into NHS funded care (Department of Health 2006, Primary Care Commissioning 2014). If the patient does not meet the eligibility criteria and wishes to appeal the decision, they are recommended to contact the Local Health Board (LHB) and the case would be taken forwards to the Orthodontic appeals panel to reassess for eligibility or consider exceptional circumstances.

The NHS orthodontic workforce is currently made up of specialist orthodontists, GDPs who are Dentists with Enhanced Skills (DwES) in orthodontics and orthodontic therapists.

Orthodontic activity is monitored by LHBS by the means of FP17OW forms. It is a mandatory requirement for performers to complete the same form at the start and within two months from the end of treatment for every patient (National Assembly for Wales 2006). The form records data regarding: the provider, patient, exemptions and remissions, orthodontic assessment, orthodontic treatment (appliance type, extractions, number of arches treated) and orthodontic completion (including if the treatment was completed of discontinued). The data could be analysed to identify any outliers although this is not currently undertaken.

An inquiry into orthodontic services was undertaken by the National Assembly for Wales Health and Social Care Committee to ascertain whether the current level of funding for orthodontics is sustainable with spending pressures faced by the NHS (National Assembly for Wales 2014). Several respondents including the British Orthodontic Society, Cardiff and Vale

University Health Board, South East Wales Local Orthodontic Committee and Managed Clinical Network (MCN), British Medical Association Wales and the Welsh Consultant Orthodontic Group noted that there was insufficient funding to meet the treatment needs of the population. They suggested that to ensure that patients who are most in need of treatment receive appropriate care, the IOTN threshold could be increased from IOTN DHC 3 with a minimum AC of 6 to IOTN DHC 4 and 5 only. It has also been recommended that existing contracts should not automatically be extended and that value for money and quality be assessed. As a consequence, Local Health Boards were requested by the National Assembly to conduct detailed assessments of performer treatment profiles and consider re-negotiation of contracts (Richmond 2015).

Although efficiency is critical for a modern orthodontic service, reducing the cost of each case should not be at the expense of clinical outcomes.

There are increased NHS spending pressures, upcoming renegotiation of orthodontic contracts and prioritisation of the dental budget towards other dental specialties (National Assembly for Wales 2018). Therefore, research is required to assess the quality of orthodontics provided and potential predictors of treatment outcome to assist in justifying government spending and enable procurement of high quality services.

Known patient factors affecting outcome include social class (Joury et al. 2011, Turbill et al. 1999) and malocclusion severity in terms of start-PAR score (Firestone et al. 1999, Taylor et al. 1996). There is varying evidence regarding which patient gender (John et al. 1994, Willems et al. 2001) and malocclusion type (Burden et al. 1998, Vu et al. 2008, Willems, Heidbuchel, Verdonck and Carels 2001) achieves a better occlusal outcome.

Regarding practitioner factors affecting outcome, evidence suggests that practitioners with specialist status are able to achieve a better outcome (Richmond et al. 1992). There is a lack of evidence regarding other practitioner factors that may affect treatment outcome.

There is a consensus that the treatment factors affecting outcome include the number of arches treated (Fox 1993, Teh et al. 2000), appliance type (Richmond, Shaw, et al. 1993) and completion/discontinuation status (Richmond and Andrews 1995). There are varying results regarding treatment duration (Dyken et al. 2001, Knierim et al. 2006). Most of the studies reporting on number of arches treated and appliance type used were conducted when use of removable appliances and single arch treatment were undertaken more commonly - their use has reduced over the years and currently, dual arch fixed appliances are the most common treatment modality (Health and Social Care Information Centre 2015).

The PAR index is valid, reliable and reproducible with excellent intra- and inter-examiner reliability (Richmond 1990). Quality of care and outcome of treatment is monitored using the PAR index and has become a contractual NHS requirement. Twenty consecutively completed cases are selected by the LHB to be rated by a named, independent and calibrated examiner each year. With PAR being regarded as a British index, representing British opinion, Index of Complexity, Outcome and Need (ICON) was developed as an international index which can also assess complexity and need as well as outcome. It has been suggested that ICON is more stringent at assessing outcome than PAR (Fox et al. 2002).

Previous studies commonly report outcome as a change in PAR/ICON score and few with end-PAR/ICON score. Change in a score is useful for measuring the amount of improvement achieved. If outcome is considered as change or percentage change in PAR/ICON score, a confounding factor is that the start-PAR/ICON score is used to calculate the change in score. This makes it difficult to assess other predictive factors against outcome without the possible confounding factor of the start-score. It has also been suggested that improvement measures are less sensitive than end-treatment scores as they introduce more errors into the analysis (Norman 1989). For that reason, end-scores should also be taken into consideration when reporting outcome. An end PAR score of ≤5 indicates an almost ideal

occlusion, end PAR score of ≤10 indicates acceptable (Richmond, Shaw, Roberts and Andrews 1992). An end ICON score of <31 indicates an acceptable occlusal outcome (Daniels and Richmond 2000).

This study was a result of a collaboration between South East Wales orthodontic Managed Clinical Network and Cardiff University School of Dentistry. The aim of this exploratory study was to determine if provider, patient and treatment factors can predict treatment outcomes measures with PAR/ICON.

Material and Methods

A retrospective, observational cross-sectional study.

Setting

Specialist orthodontic practices (providing orthodontic treatment only) or general dental practices (providing a mix of general dentistry, orthodontic and potentially other specialist services) providing NHS orthodontic treatment in the three Local Health Boards (LHBs) in South East Wales: Aneurin Bevan University Health Board, Cardiff and Vale University Health Board and Cwm Taf University Health Board. The population covered by the three LHBs was 1,363,276 which is 41.3% of the total population of Wales (Welsh Government 2015).

Participants

All primary care NHS orthodontic performers identified by the three LHBs in South East Wales.

Sample

The contract managers of each LHB were asked by the MCN and researcher to provide a list of all orthodontic performers in their region.

The LHBs randomly selected 20 consecutively submitted cases treated in the year 2014-15 for each performer. When less than 20 cases per year were treated, all completed cases were selected. If a complete set of study models was not available for a case, the performer would have to state the reason why and request the LHB to select the next consecutively treated case.

Inclusion and Exclusion criteria

There were no specific inclusion/exclusion criteria in the selection of cases by LHBs. Any cases not submitted at the end of treatment would not have been able to be included although it is a mandatory requirement that FP17OW forms be submitted as completed within 2 months of completion of treatment.

Variables

Details regarding the patient, treatment, performer and outcome measures were recorded (**Error! Reference source not found.**).

The LHBs provided patient and treatment factors from FP17OW forms for each of the selected 20 cases. This was electronically provided to the researcher. LHBs also provided details of the type of practice the performer worked in and UOA value for each performer.

Analysis of the study models provided the remaining patient factors and outcome measures.

Performer details were collected by questionnaire. The performer questionnaire was piloted with two specialists and two non-specialist orthodontists not involved in either the

study or main sample of participants to ensure understanding and eliminate any ambiguity. Each performer was posted an invitation pack which included a consent form and Performer Questionnaire to complete if they agreed to participate in the study. Performers were given four weeks to consider participation and express any queries before the researcher contacted the practice to seek a response. The questionnaire sought information on: gender, specialist status, years of orthodontic experience, number of sessions practicing orthodontics, use of orthodontic therapists (percentage of cases where an orthodontic therapist is involved in the majority of the treatment), practice worked in (orthodontic only or mixed).

Outcome measures were collected by the investigator applying occlusal indices to start- and end-study models. Performers were asked to provide any supplemental information they felt necessary for PAR, IOTN and ICON such as missing teeth, impacted teeth, displacements). Data was entered directly into Statistical Package for the Social Sciences (SPSS) (v.20.0.0).

Bias

Consecutive case sampling with no exclusion criteria increases the validity of the study and reduces the risk of selection bias.

All occlusal indices (IOTN, PAR and ICON) were recorded by one examiner calibrated to the gold standard to reduce the risk of measurement bias. Intra-operator reliability was assessed twice by the investigator re-scoring 30 randomly selected cases halfway through and at the end of data collection.

For performer factors, the performer questionnaires were collected by the researcher after all study models had been assessed in order to prevent the researcher knowing unecessary performer information prior to analysing study models. Due to the nature of assessing the study models at practice locations, the researcher was unable to be blinded to the

practice setting and would have been able to identify if a practice was a specialist or mixed practice but not necessarily if it was corporate or independent.

Patient and treatment factors were unaffected and free from bias as this information was obtained from the LHBs after analysis of study models had been undertaken.

Statistical methods

Since the study was an exploratory study of factors that predict or influence treatment outcomes and not a simple comparative trial, there was no hypothesis.

Reliability testing

The reliability of PAR, ICON and IOTN was assessed by the investigator rescoring 30 randomly selected cases at two different phases – phase 1 was completed once half of the 495 cases had been assessed and phase 2 once all 495 cases had been assessed.

Intra-operator reliability was assessed for IOTN, DHC and AC using Kappa statistics. The predetermined level of agreement required was a lower confidence interval >0.6 indicating 'substantial' agreement. For PAR and ICON, Bland-Altman plots (Bland and Altman 1999) were used. For PAR, the mean difference should be less than 2 PAR points with the Root Mean Square (RMS) of less than 5 with no bias. For ICON, the mean difference should be less than 7 with a RMS of 9 with no bias (Brown and Richmond 2005).

Predictive modelling

Individual variable significance testing was undertaken as a screening tool, initially investigating for association with a good occlusal outcome. Chi square tests were used for categorical data while Independent T-tests/Kruskal-Wallis H and Pearsons correlation were used for continuous data. A multivariate logistic regression model was undertaken to determine predictive factors of End-PAR score (≤5). All independent variables that indicated

clinical relevance and/or statistical significance in univariate analyses were tested in the model. The modelling strategy employed was to start with a full model with the least predictive variable removed at each iteration. Predictors of end-PAR score (≤5) were tabulated with Odds Ratios (OR) and associated 95% CI.

Checks for potential multicollinearity of predictors were undertaken using crosstabs and Chi Square tests of association, Independent T-tests and correlation where appropriate for data types. For prediction of change in PAR score, a multiple linear regression model was undertaken. Correlation was undertaken to ensure no multicollinearity was present as assessed by Durbin Watson statistics. This ensures that there are no confounding factors within the analysis.

Results

A total of 28 performers were identified. One performer had no orthodontic activity in the chosen year and one performer failed to respond. Therefore 26 respondents were included in the study (96.3% response rate). Two respondents completed less than 20 cases in the year, so all of their completed cases were assessed. Four hundred and ninety-five sets of models were assessed.

Of the respondents, 19 out of 26 (73.1%) were registered as an orthodontic specialist with the UK General Dental Council. Six non-specialist respondents had gone through the local accreditation process of being recognised as a DwES by the LHB and one performer was recognised as a DwES although had not undergone the accreditation process. There were more female respondents than males (n-16, 10 respectively). The respondents worked on average 4.5 (SD 2.8) sessions in the GDS/PDS per week. Twenty-two respondents worked in non-corporate practices with the remaining four respondents working in corporate owned

practices. Four respondents used orthodontic therapists to treat their caseload which ranged from 5-100%. Specific cases treated by therapists were not identified.

The Units of Orthodontic Activity (UOA) – which is an activity target used for commissioning NHS orthodontic services in England and Wales, value ranged from £62.78 to £67.66 (mean £65.93). The mean UOA was marginally higher for non-specialists (£66.23) than specialists (£65.85).

Only 23% of respondents (n-6) provided all the study models that were requested. The reason for this in 93.3% of unavailable cases was that the study models could not be located. Other reasons included the patient being transferred to hospital, the patient being too distressed to take impressions and that a digital scan was taken in a different practice location. The initial rate of cases not available was 9.1% prior to further cases being selected by the LHBs.

Reliability of Measurements

Reliability of IOTN was 'substantial' to 'almost perfect' (**Error! Reference source not found.**). The Kappa scores were all above 0.60 which was pre-determined to the be level where substantial agreement has been achieved (Landis and Koch 1977). The mean difference in reliability testing for PAR and ICON is also seen in **Error! Reference source not found.**.

Error! Reference source not found. presents Bland-Altman plots used to assess the reliability of PAR and ICON in phase 1 and 2. The mean difference for PAR was: phase 1: -0.40 (SD 1.80, 95% limits of agreement: -3.99 to 3.99), phase 2: 0.03 (SD 1.59, 95% limits of agreement: -3.15 to 3.22). This represents a potential error of up to 3.99 and 3.19 respectively

which is below the level of pre-defined clinical significance of +/-12 for PAR (Brown and Richmond 2005).

The mean difference for ICON was: phase 1: 0.45 (SD 4.55, 95% limits of agreement: -8.65 to 9.95), phase 2: 0.47 (SD 3.39, 95% limits of agreement: -6.32 to 7.25). This represents a potential error of up to 9.30 and 6.79 respectively which is below the level of pre-determined clinical significance of +/-18 for ICON (Brown and Richmond 2005).

Patient sample

There were 495 patients (females, 62.4%; males, 37.6%) assessed with an age range from 8.3 to 20.0 years (mean age 14.0 years; SD 1.7). The most common malocclusion was Class II division 1 (45.0%) followed by Class I (39.6%), Class II division 2 (8.7%) and Class III (6.7%). An incidental finding was that 20 cases (4%) that received NHS orthodontic treatment did not meet the eligibility criteria according to IOTN (

Table 1: Variable data

Patient factors	**Treatment factors**	**Performer factors**	**Outcome measures**

• Gender
• Age
• Malocclusion type (Class I, II/1, II/2 or III)
• Deprivation according to the Welsh Index of Multiple Deprivation
• IOTN:
  • DHC
  • AC
• Start-PAR score
• ICON
  • Start score
  • Need
  • Complexity
	• Extraction decision (yes/no)
	• Appliance type (fixed/removable/ functional)
	• Single or double arch treatment
	• Duration of treatment (months)
	• Treatment status (completed/discontinued)
		• Gender
		• Orthodontic specialist status as registered with the General Dental Council (yes/no)
		• Years of Orthodontic experience excluding training
		• Number of sessions practicing Orthodontics
		• Use of Orthodontic therapist (yes/no)
		• Type of practice worked in (specialist/mixed)
		• Type of practice worked in (independent/corporate)
		• Unit of Orthodontic Activity value
			• PAR:
			  • End-PAR score
			  • Change/percentage change in PAR score
			  • PAR outcome category
			• ICON:
			  • End ICON
			  • ICON improvement grade

Table 2: Reliability results for IOTN, PAR and ICON

	Kappa	**P-value**	**Standard Error**	**95% Confidence Interval**	
				Lower	Upper
IOTN DHC Phase 1	0.83	0.000	0.12	0.60	1.06
IOTN DHC Phase 2	1.00	0.000	0.00	1.00	1.00
IOTN AC Phase 1	0.72	0.000	0.09	0.53	0.90
IOTN AC Phase 2	0.74	0.000	0.09	0.56	0.92

	Mean Difference	P-value	Standard Deviation	95% Confidence Interval	
				Lower	Upper
PAR Phase 1	-0.40	0.090	1.80	-0.86	0.06
PAR Phase 2	0.03	0.870	1.59	-0.38	0.45
ICON Phase 1	0.45	0.470	4.55	-0.73	1.63
ICON Phase 2	0.47	0.290	3.39	-0.41	1.34

Table 3: Bland-Altman plots to show intra-operator reliability for PAR and ICON

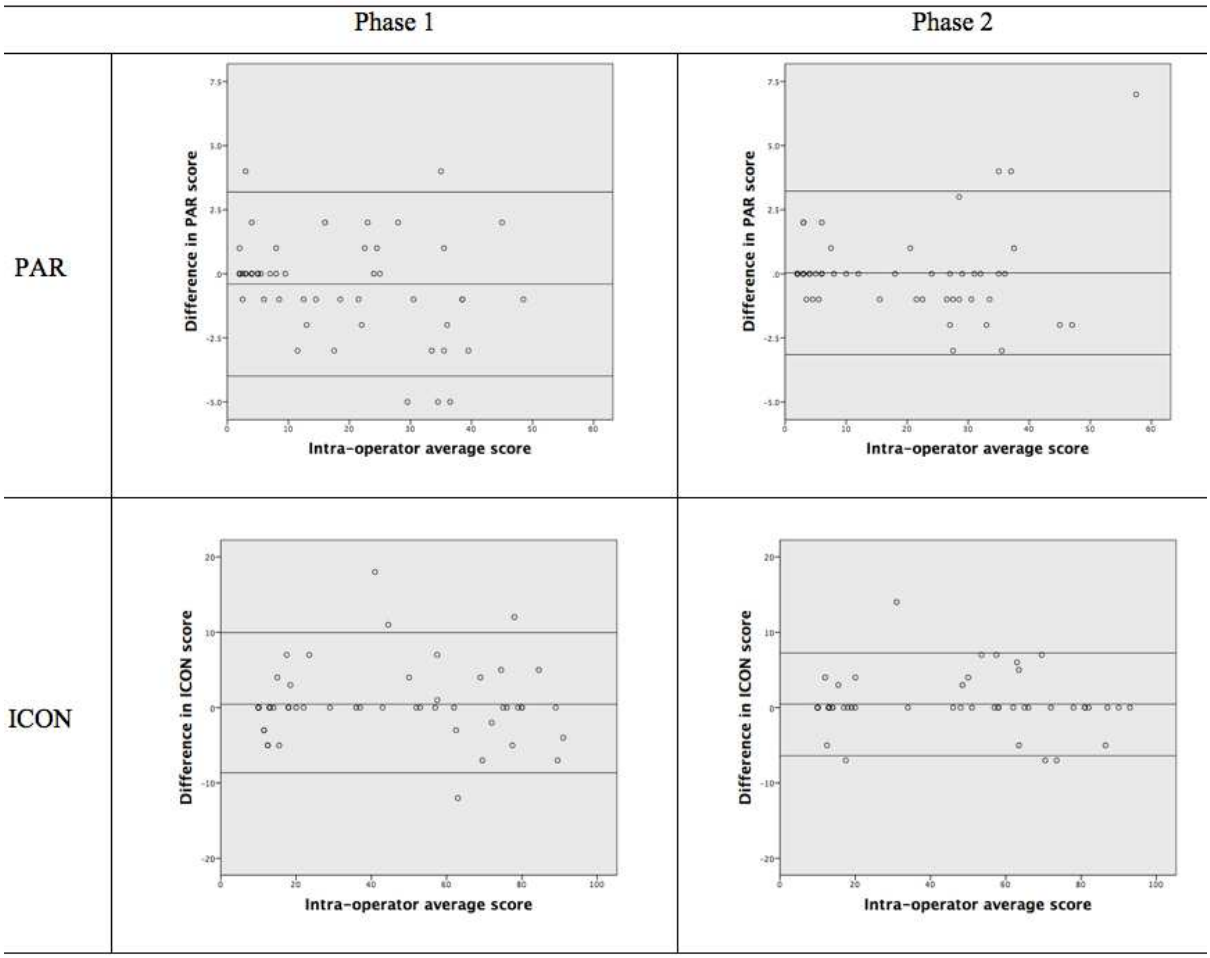

Table 4). No cases had been through an appeal procedure. There were 33 cases where the start ICON was ≤43 indicating no need for treatment (6.7%). There was an even distribution of patients treated from different areas of deprivation (Welsh Index of Multiple Deprivation) in South East Wales (Figure 1).

In 94.6% of cases, upper and lower fixed appliances were used. Extractions were undertaken in 52.5% of patients. Fourteen cases (2.8%) did not complete treatment and were recorded as 'discontinued'. Treatment duration ranged from 4-73 months (mean 21.6 months, SD 8.8). Sixty per cent of treatments were completed within 1-2 years.

Treatment outcome

The PAR score analysis is presented in

Table 5. The start PAR score ranged rom 5 to 65 with a mean of 28.8. The mean end-PAR score of 5 (SD 3.5) is collectively a good outcome. There were 28 cases (5.6%) that had an end-PAR score greater than 10 indicating further need for orthodontic treatment.

An acceptable occlusal outcome according to ICON (end-ICON score <31) was achieved in 94.9% of cases, although 1.0% of cases had an end-ICON of > 43 indicating a residual need for treatment.

Predictors of outcome

The end-PAR and end-ICON scores were assessed. The cut-off point for PAR score was 5, indicating an almost ideal occlusion when ≤5 (Richmond, Shaw, Roberts and Andrews 1992) and for ICON it was 31, where <31 indicates an acceptable occlusal outcome (Daniels and Richmond 2000). As 94.9% achieved an acceptable outcome (based on end-ICON score), it was decided to assess the predictors of high quality outcomes based on the end-PAR score of ≤5.

Therefore, outcomes measures were:

End PAR score ≤5 = High Quality of outcome achieved

Change in PAR score = Improvement achieved

Individual variable significance testing was undertaken as a screening tool for further multivariate modelling (

Table 6). Tests for association were undertaken purely as a screening tool to reduce the number of independent variables used in the regression model and the results do not represent definitive significance.

The multivariate logistic regression analysis was statistically significant ($X^2(4) = 81.64$, $p<0.001$) to assess for predictors of a high quality outcome (End PAR score ≤5). There were no confounding factors between significant independent variables. Those who have dual arch treatment were 7.98 times more likely to achieve a good outcome compared to single arch treatments. In addition, non-corporate practices, use of functional appliances prior to fixed appliances and specialist respondents were more likely to also achieve high quality orthodontic outcomes (

Table 7). Although treatment duration and start PAR score were statistically significant, as the odds ratio is close to 1, these factors are not likely to be clinically significant.

The multiple regression model was statistically significant in predicting the improvement achieved (the change in PAR score): ($F(4,488)=49.74$, $p<0.001$; Change in PAR score = -6.21 + (3.13 x IOTN AC) + (5.20 if IOTN DHC 4-5) + (5.04 if dual arch treatment) + (2.83 x malocclusion type)). There was no correlation between factors/confounding factors (Durbin-Watson statistic of 1.87). The regression coefficients (

Table 8) indicate that an increased start-Aesthetic Component by 1 is associated with a change in PAR of 3.13. An increased start-Dental Health Component from 1-3 to 4-5 increases the change in PAR by 5.20. A change in malocclusion type from Class I is associated PAR score of 2.83 for Class II and 5.66 for Class III. The predicted change in PAR score for dual arch treatment is 5.04 PAR points higher than that predicted for single arch (dependent on all other variables being constant).

Discussion

Although it is mandatory under the NHS contract to record PAR scores in a significant proportion of treatment cases and this study was supported by the Managed Clinical Network with memberships from LHBs, orthodontic service providers, academia and dental public health, one performer failed to respond. It is of concern that 9% of the dental casts requested

were not available. Also, twenty cases (4.0%) did not meet the IOTN eligibility criteria for the NHS orthodontic treatment. This is much higher than the 0.2% reported by NHS Business Service Authority in England and Wales, 2014-15 (Business Service Authority 2016) although less than 12% reported in 2001 (Turbill et al. 2001). Based on individual provider UOA values for the specific ineligible cases, the total cost of unnecessary treatment was £27,811.14. This represents an unnecessary cost which could have been used to treat eligible patients waiting for treatment. In addition, these low IOTN cases were less likely to achieve a significant improvement in malocclusion which is consistent with the findings reported by Teh et al.(2000). Requiring performers to be calibrated on the use of IOTN could be considered by LHBs.

The suggestion from some of the respondents to the national inquiry into orthodontic services undertaken by the National Assembly for Wales of increasing the NHS eligibility for orthodontic treatment to IOTN DHC 4 and 5 only was explored. Although there was no difference in end-PAR score ≤5 between the IOTN DHC 1-3 (ineligible) and 4-5 (eligible), there was a difference in change in PAR score (20 and 29 respectively) indicating more value for money in terms of improvement achieved for eligible cases. In this sample, in addition to the 4.0% already ineligible under the current IOTN criteria, the increased threshold would add a further 3.9% of cases into the ineligible category (7.9% in total).

Factors influencing high quality of treatment outcome (End PAR score ≤5)

Dual arch fixed appliance treatment is more consistent in achieving a low end-PAR score which corresponds with the findings by Turbill et al. (1999). The results support use of dual arch treatment as a norm, as recommended by The Commissioning Specialist Dental Services (NHS England 2015). Single arch treatment should only be undertaken where the

same quality of outcome can be achieved or where it would be detrimental to dental health to treat both arches e.g. treatment of lower arch in Class III camouflage patients.

Specialists have odds of having the outcome of end-PAR score ≤5 that is 2.38 times higher than non-specialists /DwESs. This may be due to the increased skill level and training obtained by specialists particularly in planning, finishing and detailing.

Treatment undertaken in non-corporate practices have odds of having end-PAR score ≤5 that is 3.77 times higher than those in corporate practices. The reasons for this difference is unknown and larger studies with more corporate practices included will be required to understand these findings.

Factors influencing improvement (Change in PAR score)

A patient factor that influenced change in PAR score was malocclusion classification. Class III malocclusions had the most change in PAR score and Class I malocclusions the least. This concurs with the results found by Willems et al. (2001). However, this is not relevant to service commissioning as the type of malocclusion cannot be controlled.

A difference in improvement was found between cases with differing IOTN DHC and AC. The results show that there is a greater change in PAR score where there is a higher need for treatment. This corresponds with the findings by Fox et al. (1997) that patients with the greatest need of treatment benefit most from treatment in terms of improvement.

Assessing treatment factors, dual arch treatment resulted in a predicted change that was 5.04 PAR points greater than single arch treatment. Dual arch being superior to single arch treatment in terms of change in PAR score is widely reported in previous studies (Fox 1993, O'Brien et al. 1993, Richmond, Andrews, et al. 1993, Teh, Kerr and McColl 2000).

Factors not influencing treatment outcome

Although the numbers of respondents utilising orthodontic therapists was low, there was no

significant association in outcome for both end-PAR score ≤5 and change in PAR score. There was no significant association detected in change in PAR and end-PAR score ≤5 between varying UOA values within the range included in this study. Although these findings are only exploratory, It is the opinion of the authors that they could potentially indicate value for money in NHS orthodontics with utilisation of therapists and standardising the national UOA value and aligning it to be consistent with patient reported and objective clinical outcomes. Once a national UOA value and expected level of outcomes are agreed, LHBs as local commissioners could be advised to use local flexibility to adjust the UOA value taking into considerations of certain criteria such as rurality and other performance indicators.

Considerations for service commissioning

For the upcoming renegotiation of NHS contracts, commissioning bodies should consider procurement of high quality services and value for money by setting standardised criteria. The following could be considered:

- All records must be available for monitoring.
- All performers should be calibrated in the use of IOTN and undertake recalibration every 5-10 years. Undertake audits on IOTN reporting.
- Increasing the eligibility threshold to accept IOTN DHC 4-5 only would mean that 7.9% of cases would not be funded in this study.
- Ensure the majority of treatments undergo dual arch fixed appliances where appropriate. The ratio of single and dual arch treatments could be used as a performance indicator to highlight any outlying performers.
- Encourage a multi-skilled model whereby specialists lead the service, supporting DwES and orthodontic therapists. With an increased use of therapists, further studies can be conducted on outcomes achieved.

Study limitations

This study is undertaken in 3 Local Health Boards in South East Wales and may not be representative of the whole of Wales or other areas of the UK. This study is retrospective and

not all records for the consecutive cases selected by the LHB's were available which may have introduced a selection bias if poor outcome cases were not available. The scope of the study restricted full examination of all the factors influencing the outcome of orthodontic treatment and therefore the generalisability of the study findings is reduced. There were small sample sizes for: single arch treatment (5.5%); cases treated with functional appliances and subsequent fixed appliances (8.5%); respondents who work in corporate practices (15.4%); and non-specialists (26.9%). These are factors were predictive of an end-PAR score ≤5 and explain the wide confidence intervals (Table 4 and 5) in predicting treatment outcome. Nevertheless, the findings do provide insight in to the local provision of orthodontic treatment in South East Wales.

Conclusions

Dual arch fixed appliances undertaken by orthodontic specialists in non-corporate environments produced the highest quality orthodontic outcomes. Those who have the highest need for treatment according to IOTN DHC and AC benefit most in terms of improvement achieved in PAR score.

Overall, good orthodontic treatment outcomes were achieved by NHS practitioners in South East Wales. However, this study also highlights the importance of regular monitoring of the IOTN criteria for NHS orthodontic treatment and any variation in orthodontic treatment outcomes achieved by practitioners and practices. Future national contract changes, development of orthodontic service specifications and local commissioning exercises should consider the findings of this study and ensure effective systems of monitoring and evaluation of existing services are in place.

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Table 1: Variable data

Patient factors	**Treatment factors**	**Performer factors**	**Outcome measures**

• Gender
• Age
• Malocclusion type (Class I, II/1, II/2 or III)
• Deprivation according to the Welsh Index of Multiple Deprivation
• IOTN:
  • DHC
  • AC
	• Extraction decision (yes/no)
	• Appliance type (fixed/removable/ functional)
	• Single or double arch treatment
	• Duration of treatment (months)
		• Gender
		• Orthodontic specialist status as registered with the General Dental Council (yes/no)
		• Years of Orthodontic experience excluding training
		• Number of sessions practicing Orthodontics
		• Use of Orthodontic therapist (yes/no)
			• PAR:
			  • End-PAR score
			  • Change/percentage change in PAR score
			  • PAR outcome category
			• ICON:
			  • End ICON

• Start-PAR score
• ICON
  • Start score
  • Need
  • Complexity
	• Treatment status (completed/discontinued)	• Type of practice worked in (specialist/mixed)
		• Type of practice worked in (independent/corporate)
		• Unit of Orthodontic Activity value
			• ICON improvement grade

Table 2: Reliability results for IOTN, PAR and ICON

	Kappa	**P-value**	**Standard Error**	**95% Confidence Interval**	
				Lower	Upper
IOTN DHC Phase 1	0.83	0.000	0.12	0.60	1.06
IOTN DHC Phase 2	1.00	0.000	0.00	1.00	1.00
IOTN AC Phase 1	0.72	0.000	0.09	0.53	0.90
IOTN AC Phase 2	0.74	0.000	0.09	0.56	0.92
	Mean Difference	**P-value**	**Standard Deviation**	**95% Confidence Interval**	
				Lower	**Upper**
PAR Phase 1	-0.40	0.090	1.80	-0.86	0.06
PAR Phase 2	0.03	0.870	1.59	-0.38	0.45
ICON Phase 1	0.45	0.470	4.55	-0.73	1.63
ICON Phase 2	0.47	0.290	3.39	-0.41	1.34

Table 3: Bland-Altman plots to show intra-operator reliability for PAR and ICON

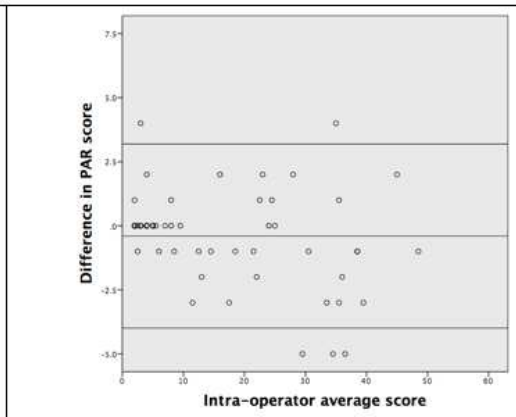
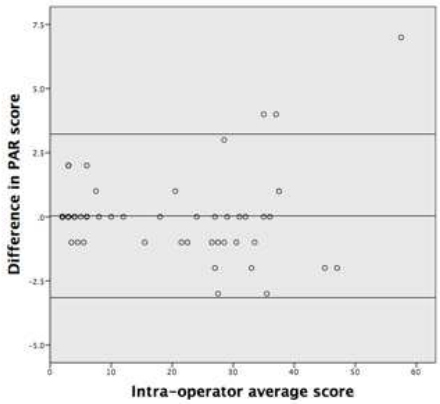
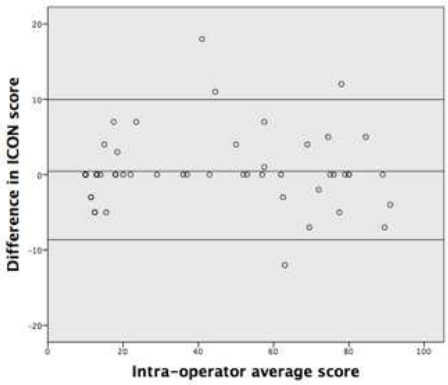
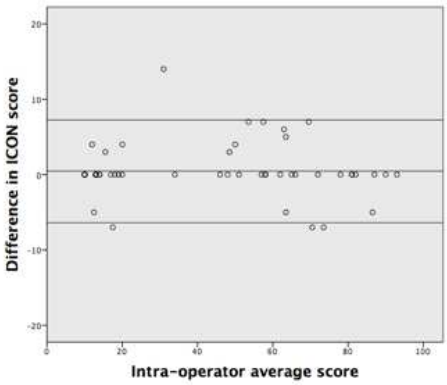
	Phase 1	Phase 2
PAR		
ICON		

Table 4: **Cross-tabulation of IOTN DHC and AC (shaded scores = ineligible)**

		IOTN DHC				
		2	3	4	5	**Total**
IOTN AC	2	0 (0.0%)	0 (0.0%)	5 (1.0%)	2 (0.4%)	**7 (1.4%)**
	3	0 (0.0%)	2 (0.4%)	4 (0.8%)	0 (0.0%)	**6 (1.2%)**
	4	0 (0.0%)	3 (0.6%)	15 (3.0%)	1 (0.2%)	**19 (3.8%)**
	5	2 (0.4%)	13 (2.6%)	49 (9.9%)	8 (1.6%)	**72 (14.5%)**
	6	0 (0.0%)	14 (2.8%)	99 (20.0%)	10 (2.0%)	**123 (24.8%)**
	7	0 (0.0%)	5 (1.0%)	110 (22.2%)	18 (3.6%)	**133 (26.9%)**
	8	0 (0.0%)	0 (0.0%)	103 (20.8%)	6 (1.2%)	**109 (22.0%)**
	9	0 (0.0%)	0 (0.0%)	13 (2.6%)	5 (1.0%)	**18 (3.6%)**
	10	0 (0.0%)	0 (0.0%)	2 (0.4%)	6 (1.2%)	**8 (1.6%)**
	Total	**2 (0.4%)**	**37 (7.5%)**	**400 (80.8%)**	**56 (11.3%)**	**495 (100%)**

Table 5: PAR score results for all cases

PAR variable	Minimum	Maximum	Mean	Standard deviation	95% Confidence Interval	
					Lower	Upper
Start-PAR	5	65	28.8	10.9	27.8	29.7
End-PAR	2	36	5.0	3.5	4.7	5.3
Change in PAR	-1	62	23.7	10.8	22.8	24.7
Percentage change in PAR	-20.0	96.9	80.5	14.7	79.1	81.7

Table 6: Results of individual variable significance testing against outcomes: End-PAR score; and Change in PAR score (bold values significant)

	Independent variable	p-values End-PAR score ≤5	p-values Change in PAR score
Patient factors	Gender	0.803	0.631
	Age	0.232	0.194
	Malocclusion type (Class I/II/III)	0.120	**0.000**
	Deprivation	0.511	0.265
	IOTN DHC (1-3 or 4-5)	0.367	**0.000**
	IOTN AC	0.052	**0.000**
	Start-PAR score	**0.000**	-
	Start-ICON score	0.060	**0.000**
	ICON complexity	0.448	**0.000**
	ICON need	0.165	**0.000**
Treatment factors	Extraction/non-extraction	0.632	**0.000**
	Single/Dual arch	**0.000**	**0.045**
	Fixed appliance/Functional+Fixed appliance	**0.048**	**0.039**
	Treatment duration	**0.000**	**0.000**
	Treatment completion/discontinuation	**0.042**	0.261
Performer factors	Gender	**0.001**	0.597
	Years of orthodontic experience	0.195	0.437
	Registered specialist status	**0.001**	0.767
	UOA value	0.194	0.093
	Consultant status	0.248	0.975
	Use of orthodontic therapist (Y/N)	0.547	0.237
	Percentage use of orthodontic therapist	0.060	0.883
	GDS/PDS sessions worked per week	0.730	0.604
	Total sessions worked per week	0.664	0.662
	Type of practice (Orthodontic only/Mixed)	**0.000**	0.704
	Type of practice (Non-Corporate/ Corporate)	**0.000**	0.308

Table 7: Logistic regression predicting likelihood of outcome end-PAR score ≤5 (reference category in bold)

	p-value	Odds Ratio	95% Confidence Interval	
			Lower	Upper
Single/Dual arch	0.000	7.98	3.28	19.42
Corporate/Non-corporate practice	0.000	3.77	2.19	6.65
Fixed/Functional+fixed	0.027	2.58	1.11	5.98
Non-specialist /specialist	0.001	2.38	1.42	4.00
Treatment duration	0.000	1.05	1.02	1.07
Start PAR score	0.001	1.03	1.02	1.06

Table 8: Summary of multiple regression analysis predicting improvement achieved in terms of change in PAR score

Variable	Unstandardised coefficients		Standardised coefficients	p-value	95% Confidence Interval	
	B	Standard Error	ß		Lower	Upper
IOTN AC	3.13	0.31	0.42	0.000	2.52	3.91
IOTN DHC 1-3 or 4-5	5.20	1.57	0.13	0.001	2.12	7.97
Single/dual arch	5.04	1.81	0.11	0.006	1.48	8.60
Malocclusion	2.83	0.73	0.16	0.000	1.40	4.27