**Evaluating the recruitment process into UK anaesthesia core training: doctors’ performance at selection and subsequent postgraduate training- a national data linkage study**

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Short title: **Evaluating the selection process into anaesthesia core trainingAbstract**

**Purpose of the study:** To explore which factors increase the likelihood of being deemed appointable to core anaesthesia training in the UK and whether those factors subsequently predict performance in postgraduate training.

**Study design:** Observational study linking UK medical specialty recruitment data with postgraduate educational performance, as measured by Annual Review of Competence Progression (ARCP) outcomes. Data were available for 2782 trainee doctors recruited to anaesthesia core training from 2012 to 2016 with at least one subsequent ARCP outcome.

**Results:** Both higher interview and shortlisting scores were independent and statistically significant (p≤0.001) predictors of more satisfactory ARCP outcomes, even after controlling for the influence of postgraduate exam failure. It was noted that a number of background variables (e.g. age at application) were independently associated with the odds of being deemed appointable at recruitment. Of these, increasing age and experience were also negative predictors of subsequent ARCP rating. These influences became statistically non-significant once ARCP outcomes associated with exam failure were excluded.

**Conclusions:** The predictors of ‘appointability’ largely also predict subsequent performance in postgraduate training, as indicated by ARCP ratings. This provides evidence for the validity of the selection process. Our results also suggest that greater weight could be applied to shortlisting scores within the overall process of ranking applicants for posts.

**What is already known on the subject**

* Validity evidence in relation to recruitment to other medical specialties suggests that ratings on selection assessments are largely predictive of future performance
* One regionally-based UK study of selection into anaesthetics training reported similar findings, providing some evidence for the validity of the recruitment process, though national studies are lacking

**Main messages**

* In recruitment to anaesthetics core training shortlisting and interview scores were strongly predictive of postgraduate performance, as measured by Annual Review of Competence Progression (ARCP) outcomes.
* Our findings support the effectiveness of the UK selection process for anaesthesia core training.

**Introduction**

How medical trainees are selected into training programmes influences the quality of future consultants. Ideally, applicants should be selected on those factors that subsequently predict clinical competency. In the UK, the anaesthetics recruitment process (summarised in Figure 1) is coordinated by the Anaesthetic National Recruitment Office. Successful applicants then embark on their anaesthetics training (Figure 2).

INSERT FIGURE 1 HERE

INSERT FIGURE 2 HERE

Several studies have investigated how selection scores correlate with subsequent performance 1-6. Several studies relating to General Practice have shown that performance during the selection process predicts later educational attainment 7-11. One UK, regionally-based, study of selection into anaesthetics training reported a similar picture 12. However, national studies are currently lacking.

There are a small number of national assessments in UK postgraduate training, including the Annual Review of Competence Progression (ARCP). This process is used to decide how a doctor progresses through postgraduate training and involves a panel of assessors reviewing a portfolio of evidence 13. This includes supervisor feedback and workplace based assessments. Success also requires trainees to pass the Primary Fellowship of the Royal College of Anaesthetists exams (Primary FRCA). These exams consist of two, separately taken, sections. The first section consists of a multiple choice based knowledge test, and the second is a clinically orientated test involving an Objective Structured Clinical Examination (OSCE) and a Structured Oral Exam (SOE)14. Both of these sections must be passed during core training in order to progress to higher specialist training. Failure in these exams can lead to an unsatisfactory ARCP outcome, where extended training time may be required, or the trainee may be released from programme.

If the selection measures are reasonably valid then performance on such metrics should also predict subsequent outcomes in training, taking into account the impact of selecting out unsuccessful candidates. The role of influences on both performance at recruitment and in training should be taken into account where possible. These factors could include age 15, gender 16-19, country of primary qualification 20, and ethnicity 21-24.

This study aimed to assess the validity of the anaesthetics core training recruitment process by:

* Investigating the predictors of a candidate being deemed appointable to anaesthetics core training
* Evaluating the predictors of ARCP outcomes for those who enter postgraduate anaesthetics training
* Comparing any patterns observed above in order to assess the effectiveness of selection into postgraduate training.

**Methods**

*Data sources and preparation*

We obtained selection data for applicants to anaesthetics core training during 2012 to 2016 from the Oriel database supplied to the General Medical Council (GMC). Flow of data through the study is depicted in Figure 3. Our outcome measure for recruitment was ‘deemed appointable’ rather than ‘appointed’ in order to reduce the effect of differing competition ratios across different deaneries. Shortlisting and interview performance scores were standardised as z-scores by year and selection centre (i.e. transformed to have a mean of zero and standard deviation of one). This controlled for differences across selection centres and for time. Thus, if doctors had applied more than once in different recruitment years, the mean interview and shortlisting scores for that particular cohort were used to standardise the scores.

INSERT FIGURE 3 HERE

Data for ARCP outcomes for trainees across the UK were available from Health Education England. This was linked to a database supplied by the GMC that included socio-demographic information, and recruitment data. To maintain anonymity the linkage was performed, via the doctors’ unique registration number, by the GMC. Only ‘competency-based’ ARCP outcomes were included (for example, those indicating ‘out of programme experience’ were excluded). Anaesthetic trainees were identified by their specialty, and those in ACCS Anaesthetics and CAT were coded separately to allow for comparison between the schemes.

ARCP ratings were collapsed and recoded to form a four point ordinal (ordered categorical) scale as follows: 4 = satisfactory, 3 = additional evidence required, 2 = targeted training required but no extra time, 1 = extended training time required/left programme. This allowed the ARCP outcomes to be treated as ordinal, rather than binary (satisfactory/unsatisfactory) or nominal (unordered) in nature. This means that the information contained within the ordering of the (recoded) ARCP outcomes is preserved, increasing study power. Note that, it was important to combine the categories ‘extended training time’ and ‘left programme’. This is because previously it has been shown that, within the context of multilevel modelling (i.e. multiple ARCPs nested within doctors), these two categories cannot be distinguished. This is assumed to be because the need to leave a programme is almost always preceded by a period of extended training time. In addition, unlike Pyne and Ben-Shlomo 15 we included ‘insufficient evidence provided’ as an intermediate category of outcome. This is because it was previously noted that this outcome was associated with other undesirable outcomes (compared to a ‘satisfactory’ rating) and therefore was assumed to contain, on average, some information on a trainee. Thus, this approach to recoding and modelling ARCP outcomes has previously been found to be valid, and also leads to models that, at least approximately, fulfil the ‘parallel odds’ assumption that underlies ordinal logistic regression 25.

We included gender, age (on application and at ARCP), years of NHS experience and self-reported ethnicity (dichotomised as ‘White’ or ‘Black and Minority Ethnic’ (BME)) in analyses. We also hypothesised that being a national of, or having trained in, a country with fewer resources might also affect performance at selection or in training. Therefore we controlled for the Gross Domestic Product per capita in US Dollars (GDP) of the relevant countries of nationality and qualification, using 2008 World Bank data 26.

*Statistical analyses*

Stata 14.1 was used for data management and analysis. Logistic regression was used to model the odds of being deemed appointable to anaesthetics specialty training. ‘Random effects’ (multi-level) models were used to control for multiple applications, which allowed for nesting of application events within doctors.

We also modelled the odds ratios of obtaining a more versus less satisfactory ARCP rating using random effects ordinal logistic regression models. This accounted for dependency of observations within individual doctors. Analyses were conducted both with and without ARCP outcomes associated with postgraduate exam failure. Trainees who fail the fellowship exam would be highly likely to receive a ‘sub-optimal’ ARCP rating (for example ‘extended training time required’). Therefore, there was a risk that postgraduate exam achievement could be conflated with, more general, ARCP performance. Therefore we conducted additional analyses which excluded the ARCP outcomes that were reported to have occurred in conjunction with postgraduate exam failure. This allowed us, to some extent, to disaggregate the effect of the predictors on ARCP outcomes in general from postgraduate exam performance.

For both sets of analyses, univariable and multivariable models (using a backward stepwise approach) were built. Only interaction terms that were statistically significant (at the p <0.05 level) were included in the final multivariable model. Missing data were managed using listwise deletion. Extensive missing data (greater than 5%) were only observed for the shortlisting and interview scores at specialty selection. Therefore, in order to evaluate the potential impact of the missing data on the results a series of analyses using imputed values for these variables were conducted as a sensitivity analysis (see the technical appendix for further details).

**Results**

*Descriptive statistics*

For most variables, there were relatively few missing data, except for standardised shortlist and standardised interview score. 608/2782 (22%) of standardised interview scores were missing, and 1,075 /2782 (39%) of standardised shortlist scores were missing. There were a total of 2,782 doctors who had both recruitment and ARCP outcomes available. 52.30% (1,445/2782) were males, 23.79% (661/2779) described themselves as BME ethnicity, and 26.21% (713/2720) were on the ACCS Anaesthesia training scheme compared to CAT. Further descriptive statistics can be seen in Table 1.

INSERT TABLE 1 HERE

*Modelling recruitment outcomes*

Figure 4 displays the univariable odds ratios and 95% confidence intervals. The full results can be seen in Table S1 of the technical appendix. We can see the strongest predictor of recruitment is interview score (OR 4.70, 4.18 to 5.30, p<.001). Shortlisting score is a positive, though weaker, predictor (OR 1.29, 1.17 to 1.43).

In terms of demographic predictors, older and/or BME trainees had significantly lower odds of being deemed appointable, whilst experience and gender were not significantly predictive (see Figure 2, and Table S1 of technical appendix). Nationals of wealthier countries were more likely to be deemed appointable (OR 1.58, 1.44 to 1.73). That is, for every $10,000 USD GDP, a candidate’s odds of success increased by approximately 60%. Similarly those who qualified in more affluent countries had higher odds of success (OR 1.86, 1.68 to 2.07).

INSERT FIGURE 4 HERE

The results from multivariable regression analysis are shown in Table 2. Since appointability of candidates is determined by their interview score, we excluded this variable from the analysis. Age at application (OR 0.94, 0.90 to 0.98), experience at application (OR 1.35, 1.25 to 1.47), BME applicants (OR 0.66, 0.49 to 0.90), and the GDP of place of qualification (OR 1.48, 1.05 to 2.10) were significant independent predictors of being deemed appointable. Experience at application was non-significant at univariable analysis, but significant at multivariable analysis. Shortlisting score was not an independent predictor of application success. No interaction terms were statistically significant.

INSERT TABLE 2 HERE

Some variation in the results from imputed and non-imputed datasets were observed. Notably, when the missing selection measures were imputed, shortlisting score became a significant predictor in the multivariable model, whilst experience at application became non-significant. The full results from analyses of the imputed datasets can be found in the technical appendix.

*Modelling ARCP outcomes*

Figure 5 displays the results from univariable analyses predicting ARCP outcomes, with and without postgraduate exam failures. Full results can be found in Table S2 in the technical appendix.

The strongest predictor of ARCP performance, when exam failures were included, was training within an ACCS programme. However, this becomes non-statistically significant when the effects of exam failures are eliminated. BME trainees had reduced odds of having a satisfactory ARCP outcome compared to white trainees (OR 0.61, 0.52 to 0.72). Older candidates (OR 0.90, 0.88 to 0.92), and those with more UK clinical experience (OR 0.79, 0.75 to 0.83) also, on average, had significantly less satisfactory ARCP outcomes. Once ARCP outcomes associated with postgraduate exam failure were excluded from analyses, the effect size reduced for all predictor variables. However, all the predictors, except for the training stream group (ACCS vs CAT) remained statistically significant at the p<0.05 level.

INSERT TABLE 3 HERE

The results from the multivariable regression analyses are shown in Table 3. Shortlisting (OR 1.42, 1.24 to 1.62) and interview scores (OR 1.37, 1.19 to 1.57) remained independent predictors of a more satisfactory ARCP outcome. For shortlisting score, for every standard deviation above the mean, trainees had approximately, on average, 40% higher odds of receiving a more satisfactory outcome when controlling for the influence of other variables. Age (OR 0.94, 0.91 to 0.97), UK clinical experience (OR 0.90, 0.83 to 0.97) and BME status (OR 0.69, 0.55 to 0.86) remained independently predictive of less satisfactory ARCP outcomes when exam failures were included in the analysis.

When ARCP outcomes associated with exam failure were excluded, age, experience and training stream became non-significant predictors. Interview and shortlisting scores became slightly stronger predictors after excluding ARCP outcomes associated with postgraduate exam failure. BME trainees remained significantly less likely to obtain a satisfactory ARCP outcome (OR 0.72, 0.55 to 0.93).

Results for the imputed data were similar to those from the non-imputed (original) data. The full results are contained in the technical appendix. However, in summary, using imputed data, the influence of interview scores on ‘appointability’ were somewhat diminished (though still statistically significant at the p<0.05 level) whilst that of the shortlisting scores increased, though did not reach statistical significance (p=0.11). The results for the prediction of ARCP varied relatively little between those for the imputed and non-imputed datasets.

**Discussion**

This is the first national data linkage study to investigate the predictive validity of a national recruitment process in anaesthesia with measures of in-training clinical performance in training through ARCP outcomes. We found that although shortlisting scores were not predictive of appointability, they did predict ARCP success. Interview scores were not included in recruitment analysis, however they were also predictive of ARCP. At multivariate level, shortlisting and interview scores had very similar ability to predict educational success.

We did not detect a significant difference in ARCP outcomes between the two anaesthetic training streams (ACCS and CAT) once the influence of postgraduate exam failures was controlled for. This is likely to reflect the differing structure of training, where CAT trainees are more likely to take exams from the first year.

We observed that most demographic factors were potential confounding factors – only gender and years of NHS experience were not univariable predictors of recruitment. When confounders were accounted for using multivariable analyses, age at application, experience at application, ethnicity, and GDP of place of qualification remained significant independent predictors of appointability. Interestingly, greater experience was not a significant univariable predictor of appointability but emerged as an independent predictor in the multivariable model. This apparent paradox could be explained by greater years of experience also possibly occurring in trainees who had encountered previous difficulty in obtaining places on anaesthetics or other postgraduate programmes. It may also be a mechanism of the missing data present in the study (see strengths and limitations).

Poorer ARCP outcomes could be predicted by age, experience and ethnicity in both univariable and multivariable models. However, age and experience were not predictive once postgraduate exam outcomes were removed. Previous research has shown that junior doctors aged over 29 years old are more likely to have less than satisfactory ARCP outcomes across a range of specialties 15. However, more recent research observed no significant difference between age and satisfactory ARCP outcomes within general surgery 27 . Postgraduate exam performance appeared more sensitive to increasing age than ARCP outcomes. This could be due to older trainees being more likely to have competing family responsibilities, making exam preparation more challenging, as has been suggested in previous literature relating to the first year of core training15.

GDP, of both nationality and place of qualification, were predictors of appointability, although only the latter variable was an independent predictor. Both GDP variables were also significant univariable predictors of ARCP outcome, but neither were independent predictors. This is reassuring in an NHS that continues to rely on international doctors to sustain it.

Candidates, self-reporting as BME, had approximately half the odds of being deemed appointable compared to those reporting White ethnicity. This effect appeared independent of the other factors in the multivariable model. Similarly, BME trainees had higher odds of receiving less satisfactory ARCP outcomes, even when the influence of other background variables was controlled for. This effect diminished modestly, though persisted, when ARCP outcomes related to postgraduate exam failures were excluded. Previous research shows consistently lower performance of BME trainees in UK postgraduate medical examinations 19 21 23 and ARCP 25 across a number of specialties including the anaesthetic Primary FRCA 28. The reasons underlying such differential performance are likely to be complex, subtle and multifactorial and have been much debated 24 28 29.

Our findings from this national study are in line with those reported by a smaller, regional one that observed that performance during recruitment correlated subsequent work place based assessment ratings 12.

*Strengths and limitations*

Our study used a large national dataset related to the UK anaesthesia training selection process. Moreover, we could link selection data to information relating to subsequent performance and training. A further strength of this study is that many studies investigating the validity of recruitment processes suffer from ‘attenuating effects’. That is that low performing candidates at selection do not generate an assessment score because they do not get appointed. This leads to an underestimation of the recruitment process as it fails to detect ability to filter out poorer performing candidates. However, in our study the shortlisting and interview scores were standardized according to the performance of all applicants, not just those accepted on to training schemes. Thus, this approach should correct for any attenuating effects during the statistical modelling.

The data were relatively complete with the exception of the shortlisting and interview scores. It is likely that the missing values were not ‘missing completely at random’. That is, the missing values were likely related to the values of variables that could be observed, as an applicant could not receive an interview without a shortlist score. However, we addressed this via multiple imputation as a form of sensitivity analysis. Indeed, our imputed and non-imputed results were relatively similar suggesting that most missing data were randomly missing, with the exception of shortlisting score. This is unsurprising given that the shortlisting score determines the presence of an interview. Thus, caution must be exercised when interpreting results relating to the former predictor.

Another limitation of the study is that ‘clinical experience’ could only be measured by date of registration with the GMC. Therefore years of practice outside of the UK could not be accounted for. Furthermore, due to a limited numbers of overseas trainees, we were unable to divide graduates by place of qualification (such as EEA graduates). We instead used the GDP of the country of nationality or qualification and acknowledge that this has less practical use than dividing by whether or not trainees were likely to have taken the Professional and Linguistic Assessments Board exam. This study also focused solely on anaesthetic core trainees, and the findings may not generalise to the context of higher specialist training limited. Nevertheless, it is likely that those variables we observed to predict success at core-training are likely to also apply to performance in subsequent higher specialist training. This may be especially true of educational (as opposed to clinical) outcomes and a high degree of continuity in academic performance in medicine is well recognised 30.

In the present study we used ARCP as one of the main outcomes. This metric lacks granularity and is more likely to discriminate between poorer rather than better performance. Data pertaining to Primary FRCA exam results was not available at the time of the study. Consequently a future study using the Primary FRCA as an outcome variable is likely to add more detail to the picture we have sketched here.

*Implications for policy and directions for future research*

Our finding that both interview and shortlisting scores made similar sized, independent contributions to the predict ARCP suggest that recruitment centres are correct in using both scores when ranking applicants for training posts. There is an extensive literature on the potential for bias of face-to-face interviews, though structuring the process, as at specialty recruitment, may reduce this risk to some extent. 4 12 The ideal weighting for each station should be informed by studies which are able to link data with clinical performance and our results suggest that the portfolio station should make up a significant portion of the overall selection score.

In line with previous research it was clear that certain demographic groups were less likely to be both appointed at application to core specialty training and also more likely to receive less satisfactory outcomes at subsequent ARCP. Certainly, for groups at risk of less satisfactory ARCP outcomes it may be that additional, targeted support would be beneficial. Such support could also be practical in nature, such as increased access to flexible working for those with caring commitments. The most effective approaches to supporting such individuals could be the subject of future, possibly qualitative, research.

Further research could focus on follow-up of anaesthesia trainees into higher specialist training. Performance in higher specialty trainees (STs) could be observed using subsequent ARCP outcomes, as well as performance in the ‘Final FRCA’. This exam, as with the Primary FRCA, consists of two sections, and must be passed by the end of specialty training year 4 (ST4), in order to allow entry to more advanced specialist training (ST5 to ST7).

*Conclusions*

Our findings support the effectiveness of the UK national selection process for entry to core anaesthesia training, with both shortlisting and interview scores being strongly predictive of clinical performance measured through ARCP outcomes. Demographic variables effecting appointability were also associated with ARCP outcomes.

**Acknowledgments** We gratefully acknowledge the assistance of Mr Daniel Smith at the General Medical Council for arranging the data extract used for this study

**Author contributions**MEDA led on writing, data interpretation and contributed to data analysis. LWP led on data analysis, produced the data visualisations, and contributed to data interpretation and drafting and appraising the manuscript. TG contributed to study design, editing and appraising the content of the manuscript. PAT led on study design and supervision of the project and contributed to writing, editing and appraising the content of the manuscript.

**Funding** PAT is supported in his research by a National Institute for Health Research (NIHR) Career Development Fellowship CDF-2015-08-11. This paper presents independent research part-funded by the National Institute for Health Research (NIHR). The views expressed are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health.

**Competing interests** PAT has previously received research funding from the ESRC, the EPSRC, the Department of Health for England, the UKCAT Board, and the GMC. TG has been a member of the RCOA Recruitment Committee since 2010 and Chair of the committee since 2015. He has previously been awarded funding from the Department of Health to develop and evaluate selection methods for anaesthesia training.

**Patient consent** Not required

**Ethics approval** The study relied on the analysis of de-identified routinely collected data analysed within a ‘safe haven’ environment. This was confirmed in writing by the chair of the University Of York Department of Health Sciences Ethics Committee.

**Data sharing statement** The data and associated STATA syntax used to manage and analyse the data may be made available from the GMC on request within a safehaven environment on an individual basis should a sufficient justification be provided.

**Figure legends**

Figure 1: Summary of the recruitment process into Anaesthetics Core Training.

Figure 2: Assessment pathway from medical school to the end of anaesthetics training. The focus of our study is the Anaesthetics Core Training stage (in blue).

Figure 3: Data flowchart for the study.

Figure 4: Results from univariable logistic regression analyses for an individual being deemed ‘appointable’ according to each predictor variable.

Figure 5: Univariable ARCP results for each variable showing how including and excluding exam failures affect ARCP outcomes.

Table 1: Descriptive statistics

|  |  |  |
| --- | --- | --- |
| Variable | Mean | Standard deviation |
| Age on application | 29.32 | 3.46 |
| Experience in years on application | 2.78 | 1.72 |
| Standardised shortlist score | 0.18 | 0.83 |
| Standardised interview score | 0.17 | 0.81 |
| Number of jobs applied for during study period | 2.25 | 1.31 |
| Number of jobs deemed appointable during study period | 1.49 | 0.93 |
| Age at ARCP | 30.13 | 3.33 |
| Experience in years at ARCP | 3.58 | 1.44 |
| Number of ARCPs per doctor | 1.83 | 0.93 |

Table 2: Results from a multivariable logistic regression model predicting the odds of a candidate being deemed appointable to core Anaesthetics training.

|  |  |  |
| --- | --- | --- |
| Variable | Odds ratio (95% CI) | p |
| Age at application | 0.94 (0.90 to 0.98) | .008 |
| Experience at application | 1.35 (1.25 to 1.47) | <.001 |
| BME | 0.67 (0.49 to 0.90) | .008 |
| GDP of country of PMQ | 1.48 (1.05 to 2.10) | .030 |

Table 3: Results from multivariable ordinal logistic regression analyses predicting the odds of a satisfactory vs unsatisfactory ARCP outcome amongst anaesthetic trainees. Results excluding ARCP outcomes associated with postgraduate exam failure are in the right column.

|  |  |  |
| --- | --- | --- |
|  | ARCP results |  |
|  | Including exam failure | Excluding exam failure |
| Variable | Odds ratio (95% CI) | p | Odds ratio (95% CI) | p |
| Age at ARCP | 0.94 (0.91 to 0.97) | <.001 | 0.97 (0.94 to 1.01) | .166 |
| Experience at ARCP | 0.90 (0.83 to 0.97) | .006 | 0.97 (0.88 to 1.06) | .489 |
| Standardised interview score | 1.37 (1.19 to 1.57) | <.001 | 1.35 (1.15 to 1.57) | <.001 |
| Standardised shortlist score | 1.42 (1.24 to 1.62) | <.001 | 1.28 (1.10 to 1.48) | .001 |
| ACCS vs CT | 1.43 (1.13 to 1.82) | .003 | 1.01 (0.78 to 1.32) | .934 |
| BME | 0.69 (0.55 to 0.86) | .001 | 0.72 (0.55 to 0.93) | .011 |

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