Clinical Practice Variation as a Method for Identification of Disinvestment Opportunities: A Case Study of Laser Capsulotomy

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Introduction

NHS variation in healthcare provision has been documented for over 60 years. Some variation is unwarranted, being driven by differences in clinical opinion rather than clinical need. Reduction of unwarranted variation could lead to financial and patient benefits.

Methods

We used Hospital and Episode Statistics to calculate PCT procedure rates for 181 interventional procedures adjusting for factors related to need. High variance procedures were identified using random-effect Poisson regression models. We worked with two commissioning groups to select procedures, using benchmarking to identify potential disinvestment opportunities. One group selected laser capsulotomy, for treatment of opacification following cataract surgery for more detailed consideration. We then conducted a rapid systematic review to summarise comparative effectiveness of capsulotomy against non-surgical treatments and explore the potential causes of the high utilisation.

Results

Substantial inter-PCT variation exists. For some procedures (e.g. Peripheral nerve stimulation) adjusted rates in high use PCTs were more than 20 times that of low use PCTs. There was no RCT evidence demonstrating the effectiveness of laser capsulotomy, although clinical guidelines endorse its use. High capsulotomy rates may be due to local referral pathways, but more probably reflect the procedure being performed locally in a day case rather than outpatient setting.

Conclusions

Our study confirms previous publications, (e.g. NHS Atlas of Variation) documenting the ubiquity of variation in NHS healthcare provision. PCT benchmarking is a promising method for identification of disinvestment opportunities. In our case study, £200,000 savings could be realised locally by moving capsulotomy procedures to the outpatient setting. We are currently extending this work to a second case study.

Introduction

There are over 17 million inpatient episodes,[1] costing £22bn[2], in England annually. Substantial increases in both inpatient activity (17%) and costs (28%) since 2006/7 have been accompanied by concerns that some inpatient admissions are inappropriate or avoidable.[3 4] Furthermore, large regional variations in admissions rates suggest that some care may be of uncertain or low clinical value.[5 6] The global financial downturn and subsequent constraints on healthcare budgets have increased the need to improve the value of care through disinvestment from existing, inefficiently applied healthcare interventions. However several key barriers to disinvestment remain; including lack of methodologies to identify and prioritise technologies with uncertain cost-effectiveness; political, clinical and social challenges to changing established practice and lack of evidence on the efficiency of many existing technologies.[7 8 9]

The National Institute for Health and Clinical Excellence (NICE) was established to provide guidance on the use of new and existing medicines, treatments and procedures. However evaluations of existing technologies were infrequent and, latterly, NICEs' disinvestment programme has evolved toward issuing 'do not do' recommendations reminders drawn from existing NICE clinical guidelines. Weaknesses have been identified in this process; at a recent NHS engagement workshop many attendees were not even aware of the existence of these guidelines.[10] Local initiatives by primary care trusts (PCTs) through programme budgeting and marginal analysis (PBMA) have also struggled to identify and then implement disinvestment initiatives.[11]

The need for a systematic and sustainable method to identify procedures for disinvestment has led to renewed interest in clinical practice variations. [12 13 14] Wennberg's 'Professional Uncertainty Hypothesis' suggests that some unexplained geographic variation occurs because of differences among clinicians in their belief about the value of the procedure, rather than any differences in clinical need.[15] Investigation of procedure variability can identify procedures in which high clinical uncertainty may lead to over-utilisation in some areas of the country.

Considerable regional variation in UK hospital procedure use has been demonstrated across a range clinical areas dating back to 1938[16 17 18 19] however its interpretation is not straightforward. Some variation is desirable in a patient centric health service, particularly in preference-sensitive procedures (e.g. Prostatectomy). Moreover, variation in NHS care may be warranted, caused by differences in clinical need or private healthcare provision; or due to innocuous factors such random chance and coding inaccuracies. Other potential sources of variation, which would be more useful in setting priorities for disinvestment, are due to differences in clinical opinion such as a shift towards more cost-effective procedures (e.g. minimally invasive surgery) or settings (e.g. minor surgery in primary care); variation in primary care testing and referral pathways; or variation in specialists' threshold for surgery.

Identification of the procedures with the greatest regional variation would be of most interest to national bodies (e.g. NICE and potentially the nascent NHS Commissioning Board) in providing an agenda for future reviews. Technology appraisals developed by these bodies, could reduce clinical uncertainty and lead to the limitation of inappropriate care through disinvestment in high utilisation regions. At the local commissioning level (i.e. PCTs and clinical commissioning groups (CCGs)), benchmarking is needed to select the procedures in which disinvestment would lead to greatest benefits for the local health economy.

This project aimed to exploit geographical clinical practice variations to identify procedures where clinical uncertainty may lead to over-utilisation in some regions of England. The project described in this report has four components. First, we used Hospital Episode Statistics (HES) to identify the inpatient and day case interventional procedures with the highest inter-PCT variation in use across England. Second, we used regression analyses to explore the reasons for geographic variation in procedure rates. Third, we worked with two PCT groups and used benchmarking to identify 20 procedures where high local utilisation and relatively large amounts of variation nationally suggested potential disinvestment opportunities at the local level. Fourth, for one case study high use procedure within one PCT we conducted a rapid systematic review to explore the possible causes of high local utilisation.

Methods

Stage 1: Measuring geographic variation in procedure rates

We used data from HES[20] to calculate the number of admissions for selected inpatient procedures performed between 2007/08 to 2009/10 in each PCT. The HES database contains details of all admissions to NHS hospitals in England including private patients treated in NHS hospitals and NHS patients treated in independent treatment centres. Clinical procedures are recorded using Office of Population, Censuses and Surveys (OPCS-4th revision) codes. OPCS codes are hierarchical and include more than 9,000 four character codes defining procedures at the finest level of detail. However, most of these codes are used infrequently and the fourth character may be assigned inconsistently by medical coders, therefore we elected to define procedures using the three character OPCS codes (n≈1,493).

We focused on the most clinically and economically consequential procedures by including in our analysis only the 269 most widely used procedures, which account for over 90% of all inpatient admissions in which a procedure was recorded. Preliminary analysis revealed implausible utilisation rates and variation between many medical and diagnostic procedures (e.g. tuberculosis support, injection of radiocontrast material) which were thought likely to be caused by inconsistent coding across PCTs. Therefore, we excluded all diagnostic (n=34) and medical (n=45) procedures. The OPCS coding system was updated from version 4.4 to 4.5 during our study. We removed codes which changed in this update (n=9) from the analysis to reduce spurious variation due to differential uptake of the new coding systems amongst clinical coders. Hence our analysis focuses on 181 interventional procedures. Up to 24 procedures may be recorded during a single inpatient episode; we included all procedures during an episode. An inpatient spell may consist of multiple episodes if, for example, the patient is transferred to another consultants care. We included procedures from all episodes during a spell.

The unadjusted procedure rate was calculated by dividing the number of procedures undertaken on PCT residents by the total PCT population. Rates are presented as the number of procedures per 100,000 residents. In order to make valid comparisons between PCTs, procedure utilisation rates are standardised to account for differences in demographics, socioeconomic and other population characteristics that might affect clinical need. We did not adjust for supply-side factors (e.g. availability of hospital beds or surgeons) as we regarded these as invalid contributors to

warranted variation. Data on the age, sex and ethnic composition of each PCT came from the Office of National Statistics.[21 22] PCT socioeconomic data came from the Department of Communities and Local Government.[23] We used data on the regional prevalence of private medical insurance from the British Household Panel Survey[24], PCT prevalence of chronic disease from the National Centre for Health Outcomes development[25] and PCT prevalence of binge drinking, smoking and obesity from The Association of Public Health Observatories.[26] Adjusted procedure rates were calculated using a two step process. Firstly, the unadjusted procedure rate was standardised indirectly, using England as the standard population, for age and sex. A Poisson regression was used to further adjust for regional prevalence of private medical insurance coverage, PCT population deprivation, ethnicity, prevalence of chronic diseases (asthma, atrial fibrillation, CHD, CKD, dementia, diabetes, hypertension, stroke, all cause cancer) and lifestyle factors (binge drinking, obesity, smoking).

The most geographically variable procedures were identified using random effect Poisson regression models allowing for between-PCT variation in procedure utilisation. Models were fitted within a Bayesian framework using the WinBUGS software[27], which allowed us to estimate the probability of variation in utilisation of each procedure exceeding a given threshold. We defined procedures as 'very high' variance if there was a high (greater than 0.95) probability that inter-PCT variation in procedure utilisation was more than three times higher than the median inter-PCT variation for all 181 interventional procedures. Similarly we identified 'high' (2-3 times), 'average' (0.5-2 times), 'low' (0.33-0.5 times) and 'very low' (<0.33 times) variance procedures. To improve interpretability, we transformed the model based inter-PCT variance estimates into an 'utilisation ratio' which is defined as the rate in a high utilisation PCT (at the 90th centile of the random effects distribution) divided by the rate in a low (at the 10th centile) utilisation PCT. Calculating a utilisation ratio based on the variance estimates from random effects Poisson regressions rather than directly from the observed rates is a more statistically rigorous approach which appropriately adjusts for chance variability. We identified the procedures with the largest change in their variation by calculating the ratio of the 2009 and 2007 utilisation ratios.

Stage 2: Exploring the potential causes of procedure variation

We conducted exploratory analyses to examine the relationship between estimated procedure variability and a number of variables which might plausibly influence inter-PCT variation: including those that could be affected by community care quality (% of procedures performed in patients with diagnosis codes indicating chronic disease[a], % of procedures performed on frail patients [defined as being discharged into care], patient age, % of procedures performed as an emergency admission); those that may indicate a substitution of care setting or procedure (% of procedures performed as a day case, % of procedures undertaken in outpatient setting, substitute procedure [correlation less than -0.3 with another procedure within the same OPCS chapter] ; % of procedures undertaken in independent sector treatment centres); those related to the ubiquity or changing evidence base of the procedure (number of hospital trusts providing the procedure nationally, national utilisation; change in procedure use since 2007) and those related to inconsistent procedure coding (non-specific code description including 'other' e.g. Other operations on spine]). We conducted multivariable linear regression analysis on the log-transformed estimated procedure variance due to the large positive skew in the distribution and heteroscedasticity of the error terms. Model

[a] Asthma, Atrial Fibrillation, All Cause Cancer, CHD, CKD, Dementia, Diabetes, Hypertension, Stroke

parsimony was achieved by removing variables from the model if their effect size was small and confidence interval wide. We calculated standardised regression coefficients to allow comparison of regression coefficients on different scales.

Stage 3: Using benchmarking to work with PCTs to identify procedures with high local utilisation

We worked with two PCT commissioning groups to identify a procedure which may be over utilised locally. We presented a short list of 20 potentially locally over-utilised procedures to PCT commissioners, which was constructed using informal methods, comparing the rate in the PCT and the national rate. Additional details, including the diagnoses that were most frequently recorded with the procedure, substitute or complement procedures, national procedure variability and the rank of the PCT nationally, in terms of utilisation, were also made available. One commissioning group selected the 'incision of capsule of lens' procedure for further analysis and rapid systematic review.

Stage 4: Background to the technology assessment case study

Patients are referred for the 'incision of capsule of lens procedure (capsulotomy)' for treatment for posterior capsule opacification (PCO). PCO is a complication of cataract surgery, whereby the posterior capsule of the lens becomes cloudy and obscures vision. Its incidence is high; 20% of cataract surgery patients suffer PCO within 2 years. During treatment an incision is made in the posterior capsule of the lens and the cloudy tissue removed. The overwhelming majority of capsulotomies are undertaken using a neodymium doped yttrium garnet laser (Nd:YAG laser). No potential surgical comparator interventions could be found, hence the review focused on the effectiveness and cost-effectiveness of Nd:YAG laser versus non-surgical care.

Technology assessment methods

Our review included only randomised controlled trials comparing surgical versus non surgical techniques for treating PCO. We identified primary studies by searching MEDLINE, EMBASE and CENTRAL in November 2011 using terms for PCO and capsulotomy and appropriate RCT filters. We searched DARE and the Cochrane Library for previous systematic reviews. Clinical guidelines were identified by searching NICE, SIGN and the Royal College of Ophthalmologists (RCOPH) websites. Two researchers independently screened the titles and abstracts for relevant RCTs. Potentially relevant papers were retrieved and assessed for inclusion. Disagreements were resolved by discussion or recourse to a third reviewer. Several reasons for the excess of day case capsulotomy procedures were explored including statistical chance, increased risk of PCO within the PCT, lower thresholds for treatment and differences in treatment setting.

Results

Stage 1: Geographic variation in procedure rates

The 181 interventional procedures included within our study varied in terms of patients (e.g. average age of patients undergoing the procedure), type of admission (e.g. % of admissions performed as a day case) and other procedure characteristics (e.g. the number of procedures performed annually in England) (Table 1). A substantial amount of

geographic variation remains present in inpatient procedure rates after adjustment for a variety of factors relating to need (Figure 1, Table 2). For a highly variable procedure, such as 'Peripheral nerve stimulation' for the treatment of pain, the adjusted procedure rate for a high utilisation PCT (at the 90th centile) is more than 30 times that of a low utilisation PCT (at the 10th centile). In contrast, for a low variation procedure, such as total excision of kidney in renal cancer patients, a high utilisation PCT exhibits an adjusted rate only 1.2 times that of a low utilisation PCT. For some procedures, in particular oocyte recovery to treat female infertility, there are a number of PCTs in which no inpatient procedures are recorded. However, it is clear that the large variation is not solely driven by a small number of outlying PCTs but, instead, reflects a genuine spread across all PCTs (Figure 1).

The median inter-PCT standard deviation (as estimated from the random effects models) across all procedures is 0.32. However for 20 procedures (Table 2) there is a high (>95%) probability that they are more than twice as variable as the median procedure, and of these, four are particularly variable (oocyte recovery, incision of capsule of lens, neurostimulation of peripheral nerve and transluminal operations on varicose vein of leg) with a high (>95%) probability that they are more than three times as variable as the median of all 181 procedures.

The median estimated change in the utilisation ratio since 2007 among all 181 procedures is -4.3% (-6.0%,-2.7%) indicating that, on average, variation in utilisation of inpatient procedures is decreasing over time. Some procedures have seen particularly large decreases in variability (Table 3); leading to a halving of their utilisation ratio since 2007 (e.g. clearance of external auditory canal in the ear). Variation has increased in several procedures, in some cases by more than 50%, since 2007 (e.g. operations on vitreous body). Furthermore some of the procedures with the largest increases are those with the greatest variability in 2009/10 (e.g. destruction of lesion of retina which is often used to treat patients with diabetic retinopathy).

Stage 2: Exploring the potential causes of procedure variation

The multivariable analysis suggests that the strongest predicator of high inter-PCT variation is the percentage of day case admissions: procedures with a large number of day case admissions are, on average, more variable than procedures which require a longer inpatient stay (Table 4). Significant increases in procedure variation were also found for procedures undertaken more commonly in an outpatient setting, procedures that have a substitute procedure available, procedures that are performed by a smaller number of hospital trusts and procedures that have non-specific OPCS codes. There is a non linear association between procedure variability and the relative increase in procedure utilisation since 2007; variation is higher in procedures with large changes, both increases and decreases, in utilisation since 2007 compared to those procedures with moderate or no change.

Stage 3: Using benchmarking to work with PCTs to identify procedures with high local utilisation

We informally identified 20 procedures with potentially high local utilisation in our partner PCT compared to the national benchmark (Table 5). Several procedures had much higher observed utilisation in our collaborating PCT than the national average. The PCT commissioned between 292 (other operations on tongue) and 2,610 (other vein related operations) of these procedures each year. In every case the absolute and relative difference between the observed PCT rate and the national rate, after adjusting for clinical and demographic covariates, was higher than could be explained by chance alone. The adjusted rate observed in our partner PCT was ranked between 10th

(Primary open reduction of fracture of bone and intramedullary fixation) and 40th (Simple extraction of tooth) of all 152 PCTs in England. Not all 'high use' procedures were also 'high variance procedures'. For example, tonsillectomy has low variation between PCTs nationally, but a high rate was observed locally.

We decided to focus on procedures which had specific OPCS codes (for example we excluded 'other vein related operations) as we wanted to focus on single procedures where there might be a body of evidence on effectiveness and cost-effectiveness. The 'incision of capsule of lens' procedure was chosen primarily because of the large absolute difference from the national rate and high national variability.

Stage 4: Technology assessment case study

Our search for RCTs comparing the relative effectiveness of the capsulotomy procedure retrieved 1,249 records of papers. However no RCTs or studies of cost-effectiveness were identified that met the inclusion criteria. Observational studies suggest that vision related quality of life improves after Nd:YAG laser surgery for PCO. People (n= 240) aged 65 years or over at time of surgery reported marked improvement in their functional impairment as measured using the Visual Function 14 (VF14) scale with a mean of 74.4 (SD 22.2, IQ range 61.4 to 92.3) before surgery to a mean of 93.0 (SD 14.2 IQ range 92.5 to 100) 4 months after surgery. Visual Function improvements remain (VF14 mean of 82.5 [SD 26.1, IQ range 78.6 to 100]) at 10 years after surgery.[28]

The Royal College of Ophthalmologists (RCOPH) recommend the use of capsulotomy for the treatment of PCO. However the RCOPH do not discuss visual acuity thresholds or referral criteria for capsulotomy but do state that PCO should be confirmed by presence of characteristic signs visible on slit lamp examination and that symptoms are more important than tests of visual function. The RCOPH note that in some units capsulotomy is performed by appropriately trained paramedical staff.

Further quantitative analysis of the HES data revealed that the high rate observed locally was not due to differences in the demographics of the patients (Table 6) or a larger number of primary cataract procedures increasing the number at risk of PCO (Table 7). A rate so far in excess of the national average would be extremely unlikely to occur due to statistical chance alone. It is possible that the high observed rate was caused by clinicians within the PCT using a lower threshold when making treatment decisions. However, while our data do not allow us to completely discount this hypothesis, the median time from cataract removal to capsulotomy within the PCT was similar to the national time providing a strong indication that this is not the case. The highly skewed distribution of PCT capsulotomy rates (Figure 2), with many PCTs undertaking close to zero day case or inpatient capsulotomies, suggests that the high rate observed locally may be due to inter-PCT variation in setting of care. It seems likely that NHS hospital trusts in other PCTs are treating PCO in outpatient (not captured by HES inpatient dataset – cost £144) rather than day case settings (captured by the HES inpatient dataset – cost £328).

Discussion

Main Results

There is substantial variation in day case and inpatient procedure rates between PCTs in England. For the most variable procedures, use in high utilisation PCTs is more than 20 times greater than that of low utilisation PCTs. Four procedures (oocyte recovery, incision of capsule of lens, neurostimulation of peripheral nerve and transluminal operations on varicose vein of leg) were 'very high' variance (more than three times the median variance). In general, variation has decreased since 2007 however these decreases are not universal. Several procedure characteristics were found to be associated with high inter-PCT variation including the percentage of day cases and the presence of a substitute procedure.

In 2009/10 residents in our collaborating PCT had 130% (95% CI: 120%, 150%) more inpatient or day case capsulotomy procedures recorded in HES than the national average. There was no evidence comparing the relative effectiveness or cost-effectiveness of ND:Yag laser capsulotomy to non-surgical interventions however it is endorsed by guidelines and observational studies suggest it leads to improvements in visual acuity. It is likely that high local utilisation is due to a greater proportion of procedures being undertaken as a day case, rather than an outpatient setting. However a lower clinical threshold for treatment or differences in local referral pathways are also possible contributing factors. Relocation of all capsulotomies from inpatient day-case to outpatient within our collaborating PCT would lead to savings of £230,000.

Comparison with Other Studies

Numerous studies have demonstrated considerable regional variation in NHS hospital procedure use.[6 29 30] Furthermore, several of the high variation procedures identified within this study, including varicose vein operations, incision of capsule of lens and in vitro fertilization, have been recognised as exhibiting high variance elsewhere.[31 32 33] Several studies have noted the persistence of variation and shown that, for some procedures, variability has increased over time.[5 34] Differential rates of day case surgery across England have been reported elsewhere suggesting that, in agreement with our conclusions, a substantial amount of procedure utilisation variation may be due to differences in the setting of care. [5 35 36]

Implications

The substantial inter-PCT variation observed for some procedures suggests uncertainty about the appropriate rate of procedure use among clinicians in England which could lead to resource waste. It is unclear if this variation reflects inappropriate procedure use in high use PCTs or, conversely, failure to provide effective care in low use regions. Adjustment of procedure utilisation rates to their optimal level, based on PCT demographics and needs, would lead to substantial efficiency savings and patient benefits. However, definition of optimal PCT procedure rates, while simultaneously encouraging patient choice, is not an easy task.[37]

The relatively slow pace of variance reduction observed in our study indicates that current methods may not be wholly effective in standardising clinical practice. Referral management programmes, ranging from the highly active (e.g. referral management centres to assess and triage all referrals) to extremely passive (e.g. dissemination of

guidelines to clinicians), have been widely used among PCTs to increase the levels of appropriate care.[38] However, such programmes have shown only limited success and, in some cases, may increase costs.[38] Recently shared decision making, whereby patients and clinicians collaborate to choose the most appropriate treatment, based on clinical evidence and the patients preferences, has been identified as a potentially effective method to reduce variation to a level that reflects patient choice.[5 39]

Our results suggest that the strongest predictor of high inter-PCT variation is a high proportion of day case admissions. Procedures that are often undertaken as a day-case may be of lower immediate clinical need than those which require an overnight stay and therefore could be subject to greater clinical discretion or inter-PCT differences in provision. Variations may also be due to inter-PCT differences in the care setting of procedures (i.e. day case versus outpatient) or the substitution of procedures with different OPCS codes (e.g. intramedullary versus extramedullary fixation of a fractured bone). Substitutions of both the procedure and care setting may be important in determining the efficiency of patient care and could be directly influenced by PCTs. Increased variation in procedures undertaken in a lower number of treatment centres could indicate that a lack of awareness or availability of more specialist procedures could be driving variation. Higher variation in procedures with rapidly increasing or decreasing utilisation may be indicative of an evolving evidence base on procedure efficiency; systematic reviews, primary studies and effective dissemination strategies could reduce this uncertainty and help standardise clinical practice.

While our analysis does not allow us to categorically state that day case capsulotomy is over utilised in our collaborating PCT, rather than under utilised in other areas, it seems highly likely that this is the case. The Department of Health defines day surgery as 'patients who require full operating theatre facilities and/or a general anaesthetic'. By this definition, most capsulotomy procedures might be more appropriately classified as outpatient procedures although widespread inconsistencies in the recording of short-term care episodes are not uncommon[40]. According to NHS reference costs the national average unit cost of performing this procedure (HRG code BZ04Z) in the outpatient setting is £144 (18,950 procedures in 2009/10) compared to £328 in a day case setting (14,174 procedures in 2009/10). Potentially there are substantial savings, around £200,000 in our case study, for commissioners in moving this procedure from the day case to the outpatient setting. However, it is less clear whether these can be realised within local contracts. Furthermore it is unclear whether either unit cost adequately reflects the resources used to provide capsulotomy. A move to the lower unit cost in the outpatient setting may benefit the commissioners, but result in the hospital trust making a loss on each capsulotomy provided.

Strength and Weaknesses

The large sample size from HES allows substantial statistical power to investigate variations across a range of interventional procedures. Several methods of measuring variation have been used previously; these have often failed to account for random variation (e.g. coefficient of variation, external quotient) or been difficult to interpret (e.g. systematic component of variation). Our methods measure only systematic differences among PCTs and allow an easily interpretable utilisation ratio to be reported. Time trends in geographical variation have been investigated for a small number of procedures elsewhere;[5 6 34] we have extended this process allowing inferences to be made on the

time trend distribution of inpatient interventional procedures as a whole. To our knowledge, this is the first study to investigate the influence of procedure characteristics on geographical variation.

We have restricted our analysis to interventional procedures to reduce the likelihood of inconsistent coding affecting our results. However inaccurate coding is still a concern, particularly for non-specific procedure codes (e.g. other vein related operations) where varying propensity to code procedures as 'other' may be contributing to the high variation. In order to make valid comparisons between PCTs we have adjusted for a number of variables, however these adjustments are made at the PCT level, and in one case the regional level, and so may not adequately capture the complex demographics of a PCT.

The HES dataset is limited by the level of clinical data that are recorded. A lack of details on the most pertinent symptoms in determining treatment need, for example visual acuity for capsulotomy, makes it impossible to identify inter-PCT variations in treatment thresholds. The recent collection of patient reported outcomes measures (PROMs) data should allow some exploration of this issue however data is collected on only a handful of procedures (e.g. hip replacement, varicose vein treatment). Furthermore, data on outpatient capsulotomy rates were unavailable to us; it is possible that high rates of inpatient capsulotomy could be offset by low outpatient rates. While the setting of care could have important patient and economic consequences, it is difficult to understand the full implications of our findings without a fuller picture of utilisation across all healthcare settings.

Conclusions

Disinvestment in existing, inefficiently applied, inpatient procedures is an imperative in the current financial climate if recent advances in healthcare quality within the NHS are to be sustained. At the national level geographic variation is a promising method to identify the procedures in which further research or effective dissemination of current evidence would lead to the greatest benefit. At the local level PCT benchmarking may provide a method for commissioners to quickly identify areas where substantial savings could be possible

Unanswered questions and future research

This study identifies several procedures in which substantial differences in utilisation exist between PCTs. It is likely that clinical uncertainty around optimal procedure use has lead to inappropriate utilisation in some PCTs. There is a need for research funders to invest in systematic reviews and evidence-based syntheses of the most geographically variable inpatient procedures to summarise what is known about which patients should be treated and in what setting. These technology appraisals would inform recommendations on appropriate use and provide a starting point for a research agenda on the use of inpatient procedures. PCT benchmarking is a promising method for identification of disinvestment opportunities however collection of further data, including details on symptoms and outpatient appointments, is needed to allow a fuller exploration of the causes of high local utilisation. We are currently in the process of repeating this process for carpal tunnel release surgery in another PCT. Preliminary analyses suggest that high local utilisation is not due to substitution of care setting and is more likely related to variation in surgical thresholds among clinicians.

Table 1 - Procedure characteristics (n=181)

Variable	Median (IQR)[b]
Patient Characteristics	
Average Age	53.2 (42.7,62.4)
Chronic Diagnosis (%)	4.9 (0.6,26.4)
Frail (%)	0.3 (0.1, 1.1)
Admission Characteristics	
Emergency Admissions (%)	5.2 (1.1,20.4)
Day Case (%)	45.1 (10.3,79.3)
Procedure Characteristics	
Number of Trusts offering procedure	160 (149,170)
Independent Treatment Centre (%)	1.3 (0.1, 4.0)
Relative Increase since 2007	5.5 (-1.1,16.3)
Non-Specific Code	48 (26.52)
Substitute Procedure	8 (4.42)
Utilisation (10,000s)	1.3 (0.8, 2.5)
Percentage of Procedures Undertaken in Outpatient Setting	1.1 (0.1, 8.4)

[b] Median and Inter-quartile range except non-specific code and substitute procedure where counts and percentages are presented.

Table 2 -Twenty most variable procedures nationally 2009/10

Procedure	Number of Procedures	Inter-PCT SD (95% CI)	Utilisation Ratio[c] (95% CI)	Variance Probabilities[d]	
				High	Very High
Oocyte recovery	5,173	1.7 (1.5,2.0)	84.2 (46.5,154.5)	1.00	1.00
Incision of capsule of lens	16,805	1.6 (1.5,1.9)	69.2 (41.7,116.9)	1.00	1.00
Neurostimulation of peripheral nerve	10,654	1.4 (1.2,1.5)	33.1 (21.8,51.0)	1.00	1.00
Transluminal operations on varicose vein of leg	10,580	1.2 (1.0,1.3)	19.8 (13.4,29.6)	1.00	1.00
Total prosthetic replacement of knee joint not using cement	5,447	1.0 (0.9,1.1)	12.6 (9.1,17.6)	1.00	0.71
Other operations on oesophagus	10,051	1.0 (0.9,1.1)	12.2 (9.1,16.6)	1.00	0.66
Denervation of spinal facet joint of vertebra	7,779	1.0 (0.8,1.1)	11.6 (8.5,16.2)	1.00	0.53
Curettage of lesion of skin	14,207	0.9 (0.8,1.1)	11.3 (8.5,15.4)	1.00	0.47
Other operations on outlet of male bladder	31,472	0.9 (0.8,1.1)	11.2 (8.4,14.9)	1.00	0.44
Destruction of lesion of retina	26,774	0.9 (0.8,1.0)	11.0 (8.4,14.7)	1.00	0.42
Hybrid prosthetic replacement of hip joint using cemented femoral component	6,073	0.9 (0.8,1.1)	10.8 (8.0,15.0)	1.00	0.37
Excision of vas deferens	13,796	0.9 (0.8,1.0)	10.3 (7.8,13.7)	1.00	0.25
Prosthetic replacement of head of femur not using cement	8,288	0.9 (0.8,1.0)	10.1 (7.5,13.8)	1.00	0.23
Restoration of tooth	13,030	0.8 (0.7,1.0)	8.7 (6.7,11.5)	1.00	0.04
Curettage of uterus	10,186	0.8 (0.7,0.9)	7.8 (6.1,10.3)	1.00	0.01
Other operations on mouth	8,415	0.8 (0.7,0.9)	7.7 (6.0,9.9)	1.00	0.00
Other operations on eye	10,446	0.8 (0.7,0.8)	6.9 (5.6,8.8)	1.00	0.00
Other vaginal operations on uterus	12,536	0.7 (0.7,0.8)	6.8 (5.4,8.7)	1.00	0.00
Excision of cervix uteri	21,043	0.7 (0.7,0.8)	6.8 (5.4,8.5)	1.00	0.00
Other therapeutic transluminal operations on vein	16,070	0.7 (0.6,0.8)	6.4 (5.2,8.1)	0.98	0.00

[c] Ratio of utilisation in the 90th centile of PCTs in terms of utilisation to a PCT in the 10th centile of PCTs, 95% credible interval

[d] Probability that procedure is very high variance (greater than 3 times median variance) or high variance (greater than 2 times median variance)

Table 3 - Procedures with the largest increase or decrease in variability since 2007

Procedure	Utilisation Ratio 2007	Utilisation Ratio 2009	% Utilisation Ratio Change
Increasing procedure variability			
Operations on vitreous body	2.1 (2.0,2.4)	3.8 (3.3,4.5)	78.8 (49.3,115.0)
Other operations on tongue	2.5 (2.2,2.9)	3.9 (3.3,4.7)	58.4 (26.9,97.6)
Oocyte recovery	69.6 (37.3,126.1)	84.2 (46.5,154.5)	32.8 (-47.8,180.9)
Filtering operations on iris	2.8 (2.4,3.2)	3.5 (3.0,4.1)	26.9 (1.3,57.6)
Excision of cervix uteri	5.4 (4.5,6.7)	6.8 (5.4,8.5)	25.5 (-8.0,68.8)
Total prosthetic replacement of hip joint using cement	2.6 (2.3,3.0)	3.2 (2.8,3.7)	21.9 (1.1,45.1)
Other primary fusion of other joint	2.0 (1.8,2.2)	2.4 (2.1,2.7)	18.4 (-1.0,39.5)
Destruction of lesion of retina	9.6 (7.4,12.6)	11.0 (8.4,14.7)	17.4 (-21.8,71.3)
Other operations on urethra	5.0 (4.1,6.2)	5.8 (4.7,7.2)	15.9 (-15.1,54.4)
Other operations on oesophagus	10.8 (8.1,14.6)	12.2 (9.1,16.6)	15.7 (-25.9,70.3)
Decreasing procedure variability			
Clearance of external auditory canal	9.5 (7.3,12.5)	2.5 (2.2,2.9)	-72.9 (-80.3,-64.0)
Other therapeutic transluminal operations on vein	20.6 (14.4,29.5)	6.4 (5.2,8.1)	-67.9 (-79.7,-52.5)
Transluminal operations on varicose vein of leg	60.0 (33.1,109.4)	19.8 (13.4,29.6)	-63.7 (-83.6,-32.9)
Therapeutic transluminal operations on heart	5.0 (3.9,6.4)	3.0 (2.6,3.6)	-39.0 (-55.5,-19.8)
Neurostimulation of peripheral nerve	52.0 (31.5,85.5)	33.1 (21.8,51.0)	-32.1 (-67.2,23.8)
Orthodontic operations	2.8 (2.4,3.2)	2.0 (1.8,2.2)	-28.0 (-40.3,-14.7)
Endoscopic extirpation of lesion of colon	3.9 (3.3,4.6)	2.8 (2.5,3.2)	-26.2 (-40.5,-10.2)
Endoscopic extirpation of lesion of lower bowel using fibreoptic sigmoidoscope	5.0 (4.1,6.1)	3.6 (3.1,4.3)	-26.0 (-43.8,-5.8)
Block dissection of lymph nodes	2.0 (1.8,2.2)	1.5 (1.4,1.6)	-24.0 (-32.2,-15.5)
Other reconstruction of joint	4.2 (3.5,5.1)	3.2 (2.8,3.7)	-22.5 (-39.9,-2.6)

Table 4 - Multivariate analysis of factors influencing procedure variation

Variable	Percentage Change	P Value	Standardised Coefficient
Day Case	0.59 (0.36,0.83)	<0.001	0.318
Substitute	102.15 (43.23,185.29)	<0.001	0.224
Relative Increase since 2007			
Less than -3%	0.00		
Between -3% and 3%	-15.93 (-32.91,5.35)	0.134	-0.110
Between 3% and 10%	-11.23 (-29.16,11.24)	0.302	-0.074
Between 10% and 20%	20.36 (-3.84,50.66)	0.107	0.117
Greater than 20%	70.89 (35.94,114.83)	<0.001	0.324
Number of Trusts Offering Procedure	-0.45 (-0.71,-0.19)	0.001	-0.195
Percentage of Procedures Undertaken in Outpatient Setting			
Less than 1%	0.00		
Between 1% and 49%	25.83 (5.72,49.77)	0.011	0.178
Over 50%	52.36 (8.03,114.90)	0.017	0.142
Non-Specific Code	9.99 (-6.63,29.58)	0.256	0.065

Table 5 Shortlist of 20 procedures with the greatest absolute difference from national mean

Procedure (OPCS code)	Total	Adjusted Rate	National Rate	Absolute Difference	Relative Difference	National Rank	Procedure Variability
Destruction of lesion of retina (C82)	1,102	109 (103,115)	52 (51,52)	57 (50,64)	2.1 (2.0,2.2)	27	High
Simple extraction of tooth (F10)	2,083	248 (238,259)	192 (191,193)	56 (46,66)	1.3 (1.2,1.3)	40	Average
Other vein related operations (L91)	2,610	281 (270,292)	232 (231,233)	48 (37,59)	1.2 (1.2,1.3)	39	Average
Incision of capsule of lens (C73)	1,268	75 (71,80)	32 (32,33)	43 (39,47)	2.3 (2.2,2.5)	26	Very High
Excision of cervix uteri (Q01)	578	75 (69,82)	41 (40,41)	34 (28,41)	1.8 (1.7,2.0)	24	High
Endoscopic extirpation of lesion of lower bowel using fibreoptic sigmoidoscope (H23)	699	71 (66,77)	38 (37,38)	33 (28,39)	1.9 (1.7,2.0)	11	Average
Primary open reduction of fracture of bone and intramedullary fixation (W19)	938	92 (86,98)	59 (58,59)	33 (27,39)	1.6 (1.5,1.7)	10	Average
Extirpation of lesion of eyelid (C12)	733	103 (96,111)	72 (71,73)	31 (23,39)	1.4 (1.3,1.5)	22	Average
Other operations on outlet of male bladder (M70)	781	90 (84,96)	61 (60,61)	29 (22,35)	1.5 (1.4,1.6)	38	High
Destruction of haemorrhoid (H52)	444	78 (71,86)	51 (50,51)	27 (19,35)	1.5 (1.4,1.7)	26	Average
Other therapeutic transluminal operations on vein (L99)	578	55 (51,60)	31 (31,32)	24 (20,29)	1.8 (1.6,1.9)	16	High
Operations on adenoid (E20)	564	70 (65,76)	48 (48,49)	21 (16,27)	1.4 (1.3,1.6)	14	Average
Other operations on eyelid (C22)	242	33 (29,38)	16 (16,16)	17 (13,21)	2.1 (1.8,2.3)	13	Average
Other operations on tongue (F26)	292	28 (25,31)	12 (12,13)	15 (12,19)	2.2 (2.0,2.5)	11	Average
Excision of tonsil (F34)	898	113 (106,121)	98 (97,99)	14 (7,22)	1.1 (1.1,1.2)	32	Low
Other internal fixation of bone (W28)	1,185	111 (105,117)	96 (95,97)	14 (8,20)	1.1 (1.1,1.2)	32	Low
Other operations on fallopian tube (Q41)	343	38 (34,42)	25 (25,26)	12 (8,16)	1.5 (1.3,1.6)	18	Average
Prosthetic replacement of head of femur using cement (W46)	381	41 (37,46)	29 (29,30)	12 (8,16)	1.4 (1.3,1.6)	26	Average
Vaginal excision of uterus (Q08)	441	44 (40,48)	32 (32,33)	11 (7,15)	1.3 (1.2,1.5)	20	Average
Extracorporeal fragmentation of calculus of kidney (M14)	363	48 (43,53)	37 (37,38)	10 (6,15)	1.3 (1.2,1.4)	29	Average

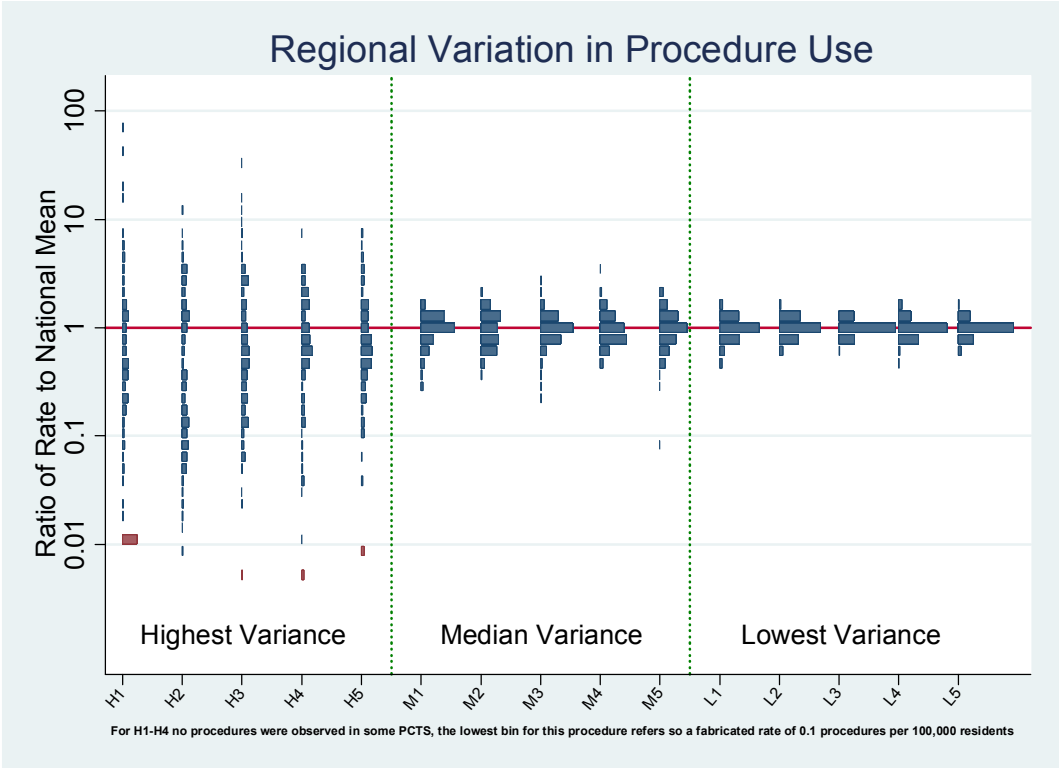
Table 6 – Demographics of patient undergoing capsulotomy in PCT1 and elsewhere

Characteristic	PCT 1 (%)	Other PCTs (%)
N	1,268	15,537
Mal	460 (36.28)	5,853 (37.67)
Mean Age (SD)	74.68 (13.79)	73.92 (14.75)
Median Episode Length (IQR)	1 (1,1)	1 (1,1)
% Day Case	1,206 (95.11)	14,690 (94.55)
Diagnosis		
Other cataract (H26)	1,057 (83.36)	13,791 (88.76)
Complications of other internal prosthetic devices, implants and grafts (T85)	176 (13.88)	426 (2.74)
Congenital lens malformations (Q12)	7 (0.55)	112 (0.72)
Other	28 (2.21)	1,208 (7.77)
Procedure		
Capsulotomy of posterior lens capsule (C733)	1,259 (99.29)	10,208 (65.70)
Capsulotomy of anterior lens capsule (C732)	6 (0.47)	312 (2.01)
Capsulotomy of lens not elsewhere classified (C734)	3 (0.24)	4,808 (30.95)
Other	0 (0.00)	209 (1.35)

Table 7 - Cataract procedures in 2007/08 - 2009/10

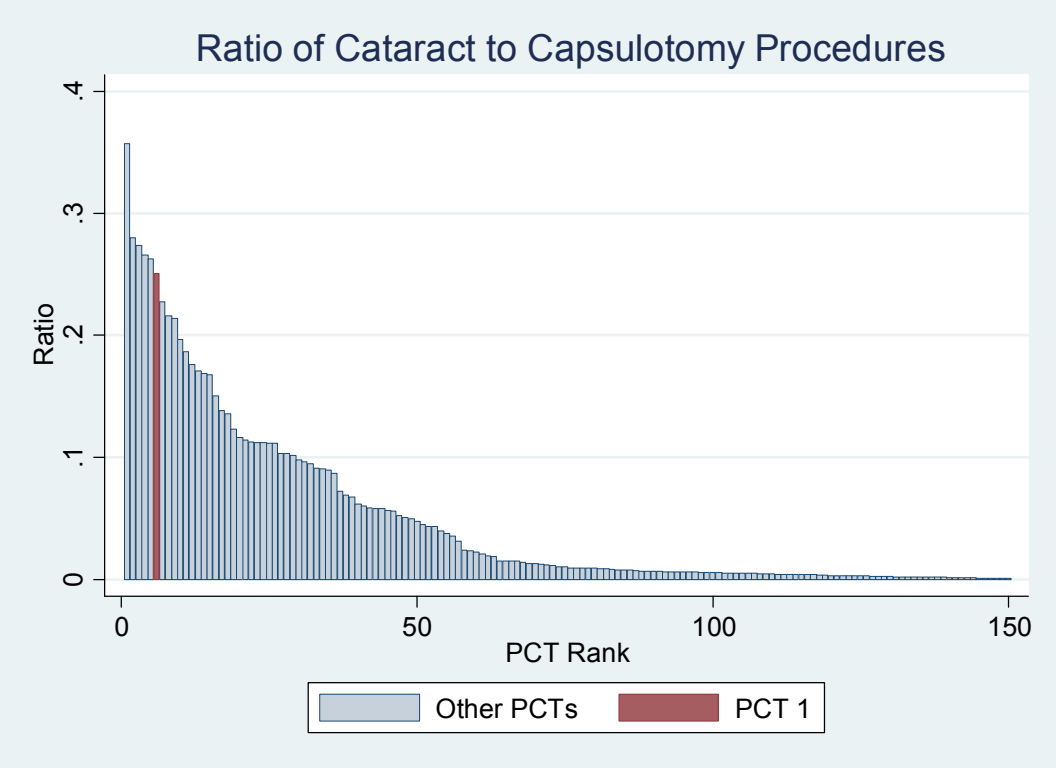
Characteristic	PCT 1 (%)	Other PCTs (%)
Rate per 100,000 residents	640.12	618.9
N	15,382	957,121
Male	6,186 (40.22)	390,013 (40.75)
Mean Age (SD)	75.16 (11.17)	74.55 (10.97)
Median Episode Length (IQR)	1 (1,1)	1 (1,1)
% Day Case	14,023 (91.16)	920,983 (96.22)
Diagnosis		
Senile nuclear cataract (H251)	6,269 (40.76)	156,760 (16.38)
Cataract, unspecified (H269)	4,693 (30.51)	616,825 (64.45)
Other senile cataract (H258)	2,979 (19.37)	33,819 (3.53)
Other	1,441 (9.37)	149,717 (15.64)
Procedure		
Insertion of prosthetic replacement for lens NEC (C751)	15,227 (98.99)	948,685 (99.12)
Removal of prosthetic replacement for lens (C753)	83 (0.54)	1,180 (0.12)
Revision of prosthetic replacement for lens (C752)	45 (0.29)	3,116 (0.33)
Other	27 (0.18)	4,140 (0.43)
Capsulotomy within 1 year	248 (5.04)	2,922 (0.96)
Capsulotomy within 2 years	554 (11.26)	5,647 (1.85)
Median Days to Readmission for Capsulotomy (IQR)	506 (270,721)	515 (189,734)

Figure 1 - – Comparison of high, median and low variance procedures



Label	Procedure
H1	Oocyte recovery
H2	Incision of capsule of lens
H3	Neurostimulation of peripheral nerve
H4	Transluminal operations on varicose vein of leg
H5	Total prosthetic replacement of knee joint not using cement
M1	Therapeutic endoscopic operations on uterus
M2	Other therapeutic transluminal operations on heart
M3	Primary open reduction of fracture of bone and intramedullary fixation
M4	Operations on canthus
M5	Transluminal operations on iliac artery
L1	Operations on hydrocele sac
L2	Operations on Bartholin gland
L3	Total excision of kidney
L4	Drainage through perineal region
L5	Other excision of right hemicolon

Figure 2 - Distribution of the ratio of day case or inpatient Capsulotomy to cataract procedures



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