

Original Article

An analysis of the academic capacity of anaesthesia in the UK by publication trends and academic units

G. Ratnayake,¹ K. El-Boghdady^{2,3} and J. J. Pandit⁴

1 Specialty Trainee, 2 Consultant, Department of Anaesthesia and Peri-operative Medicine, Guy's and St Thomas' NHS Foundation Trust, London, UK, 3 Honorary Senior Lecturer, King's College London

4 Consultant, Nuffield Department of Anaesthetics, Oxford University Hospitals NHS Foundation Trust, Oxford, UK

Summary

Over a decade ago, bibliometric analysis predicted the disappearance of UK publishing in anaesthesia by 2020. We repeated this analysis to assess if this had turned out to be the case, searching PubMed for papers associated with UK consultant anaesthetists for 2017–2019 across 15 journals. Although the rate of decline has flattened using the same search filter, including a wider range of publication types shows that outputs still remain at half 1990s levels (381 papers for all 3 years combined), authored by 769 anaesthetists, 274 of whom are associated with an academic centre. There are now 11 identifiable academic units, and a further 15 places where anaesthetists have affiliations with academic centres as individuals. The majority of papers (71%) are in secondary analysis (observational, database and association studies, surveys and meta-analyses), rather than in primary research (clinical trials or laboratory studies). These data reflect the current academic capacity in terms of publications, academic units and staffing. We discuss how this information can be used to inform a new strategy for UK academic anaesthesia.

Correspondence to: J. J. Pandit

Email: jaideep.pandit@dpag.ox.ac.uk

Accepted: 29 July 2020

Keywords: academic capacity; academic strategy; bibliometrics; h-index; publishing

This article is accompanied by an Editorial by Myles, *Anaesthesia* 2021; **76**: 452–4 and This article is accompanied by an Editorial by Yeung and Shelton, *Anaesthesia* 2021; **76**: 455–9.

Twitter: @elboghdady

Introduction

In 2008, Feneck et al. demonstrated a continual decline in publishing by the UK anaesthetists between 1997 and 2006 [1]. Extrapolating the trajectory predicted a complete cessation of publishing by 2020 [2]. Feneck et al.'s analysis reflected the then parlous state of UK academic anaesthesia that had prompted the Royal College of Anaesthetists' Academic Strategy (Pandit) Report, which made 20 recommendations [3–5]. The Report's impact had not been felt at the time Feneck et al.'s study was published, and several later analyses using different methods have indicated unabated UK academic anaesthesia publishing [6, 7], or similar performance by UK vs. non-UK anaesthetists in citation metrics [8–11]. What remains unknown is the

geographical (by centre) distribution of the UK publications, the number of research-active anaesthetists, or even how many identifiable academic units are now in existence.

These data contribute to what can be termed the 'academic capacity' of a specialty [12]. In the same way as the capacity of an industry might be understood as its ability to produce goods, published papers reflect one key output of academic anaesthesia, and a readily measurable one. Academia is arguably more sophisticated than a factory, but there are parallels. Other relevant measures of academic capacity include: staff numbers, and the time they have for academic vs. clinical activity (akin to industry workforce); research student numbers; higher degrees awarded; and grant funding (all akin to training capacity in an industry).

Quality is an important metric and although measures like the h-index may in part reflect this [13], it is more difficult to quantify in academia than in industry (e.g. 'product defect rate' is not meaningful for academic outputs). Ideally, a holistic metric incorporating all of these is required, but short of this, examining publications represents a starting point. It is important to emphasise that any analysis should not be confined only to universities, but embrace publications from the specialty as a whole, across a diverse range of centres.

We therefore conducted a bibliometric analysis, using three recent years of publications, to estimate academic anaesthesia capacity by: (a) total number of UK publications (focussing on the same journals examined by Feneck et al.); (b) publications by type (i.e. primary vs. secondary research); (c) total number of authors involved; (d) identifying discrete academic units and (e) identifying the authors associated with those units. The broad goal was to examine how much the UK specialty of anaesthesia is publishing, what it is publishing and who and how many are doing the publishing.

Methods

Feneck et al. [1] analysed papers from seven journals, namely *Anaesthesia*, *Anesthesiology*, *British Journal of Anaesthesia* (BJA), *Anesthesia and Analgesia* (Anesth Analg), *European Journal of Anaesthesiology* (EJA), *Acta Anaesthesiologica Scandinavica* (Acta Scand), and the *Canadian Journal of Anesthesia* (CJA). In addition, Feneck et al. analysed the UK publications from four 'specialist' journals, these being *Pain*, *Journal of Cardiothoracic and Vascular Anesthesia* (J Card Thor An), *Critical Care* (Crit Care), and *International Journal of Obstetric Anesthesia* (IJOA) and also four leading 'general' journals, namely the *New England Journal of Medicine* (NEJM), *Journal of the American Medical Association* (JAMA), *British Medical Journal* (BMJ) and the *Lancet*, but they did not obtain any relevant data. We searched the same 15 index journals using PubMed for the 3 years 2017–2019 for papers originating, in part or in whole, from the UK (by searching for 'UK' or 'United Kingdom' or 'Great Britain', and by each devolved nation's name). Papers were included only if there was at least one UK consultant anaesthetist (i.e. medically qualified) as an author. Within 'anaesthetist' we included anaesthetist-intensivists and anaesthetist-pain physicians.

The publications retrieved were categorised by type. *Observational studies* were prospective studies in which patient outcomes or progress were passively observed over time without any experimental or therapeutic intervention. These could include case series (but not individual case

reports, which were excluded). *Association studies* were prospective or retrospective in identified patient groups that sought to correlate certain characteristic(s) with defined outcome(s). *Database studies* were those that interrogated existing data sources such as local or national patient records. There was potential for overlap between these three classifications, since identifying a patient group for prospective observation could create a database, which could then be used to create an association of an outcome with one or more factors of interest, etc. Although the distinctions were in practice clear (e.g. by the title of a paper describing it as observational, association, etc.), these distinctions between these three types should not be regarded as absolute: they are all non-interventional. *Clinical trials* studied the effects of an intervention prospectively, in a randomised or non-randomised study design. *Physiology studies* were those that used patients or volunteers primarily to provide insights into workings of the body rather than focus on any clinical outcome. *Surveys*, *simulation* and *animal/cell studies* were readily identified, and *bench studies* were classified as those that analysed devices or non-biological material, or used cadavers. Finally, *systematic reviews and meta-analyses* had to be quantitative rather than just qualitative reviews or opinion pieces, and this category included mathematical analyses or modelling. Within this classification, 'primary research' was regarded as that from: animal/cell, physiology and bench studies, and clinical trials (i.e. where there was an active intervention to test a hypothesis). Other study designs were regarded as 'secondary research'.

Publication types that were excluded were: abstracts; symposia presentations; editorials; special articles (e.g. viewpoint); qualitative or narrative reviews; guidelines (including consensus statements based on systematic review that did not present patient outcome data); case reports; and correspondence. Papers were also excluded if, although from the UK, only trainees, non-clinical scientists or non-anaesthetist clinicians were authors.

The data from the retrieved papers were used to identify the centres to which the authors were affiliated. Where a paper had several authors, each from a different centre, each centre was given credit for the work (i.e. a single paper could add to the total publication count of several centres). Where a paper had several authors all from one centre, this centre was credited only once with the work. Individuals were counted as authors if listed as such in under the main banner or title of the full publication. They were not counted if listed only as collaborators or contributors (PubMed often lists all these as 'authors' on its website), nor counted if only part of an eponymous collaboration. From

this, we were able to estimate the total number of papers associated with a centre through any authorship, and we were able to identify the number of individuals in any centre who had been associated with a paper as an author.

Next, the website of each centre identified was searched to ascertain if there was an identifiable ‘academic unit’ (often, but not necessarily, associated with a university academic department). Our definition of ‘academic unit’ was based on the ability to locate a website that presented a group or list of named anaesthetists and, beyond just an individual’s name, there was some indication of the individual’s publications or academic interest. This was clear, for example, where the author was listed under a grouping or ‘Department of Anaesthesia, University X’. Where the author was listed as from ‘NHS Trust Y’, a search was made to ascertain whether (a) the website of Trust Y was organised to identify a group of academically active anaesthetists (e.g. with their publications or research interests), or (b) there was a university located in place Y that listed the individual as a named member.

We recognised that our definition of ‘academic unit’ does not directly correspond to the traditional concept of a ‘university academic department’. Universities recurrently re-organise themselves into various ‘themes’, ‘divisions’, ‘faculties’, etc, wherein departments as such do not exist. This did not matter for our assessment, so long as it was easy to identify named anaesthetists within a discrete academic group. This approach applied equally to NHS departments and university units; that is, the department website had to identify a group of research-active anaesthetists, rather than just list names of consultants who were members of the NHS department, with no further searchable information about their academic interests or publications. In this approach, it was not sufficient for one or two anaesthetists simply to be named as part of a wider, mainly non-anaesthesia multidisciplinary grouping; the identified group had to be predominantly formed of anaesthetists.

Where discrete academic anaesthesia units were identified, the listed names on the departmental website were searched (January 2020), using Google Scholar™ in Harzing’s database (<https://harzing.com/resources/publish-or-perish>) for their h-index.

Where discrete academic units could not be identified, we considered whether the centre had been listed in the Pandit Report as having once had an academic department, or if the affiliated author was styled a professor. If so, we searched the centre’s website for individual author and h-index.

For all authors affiliated to an academic unit, we noted if it was shown they held or had been awarded any type of

professorial title (this included professor; associate, assistant or visiting professor; specialty professor awards such as Macintosh Professor of the Royal College of Anaesthetists, Featherstone Professor of the Association of Anaesthetists, Difficult Airway Society Professor and Obstetric Anaesthesia Association Professor), regardless of whether this was in anaesthesia, or any other discipline such as medical education, simulation, psychology, physiology, etc.

The data of only medically qualified (hence ‘clinical’) anaesthetists of consultant grade were included in this ad personam analysis, regardless of whether they were NHS- or university-employed. Thus, data were excluded from individuals who were: known to be retired (e.g. emeritus) consultants; non-clinical scientists; and administrative staff.

Finally, for the names obtained on websites, we recorded data on apparent biological sex and ethnicity (black, Asian and minority ethnic, BAME) by estimation from names and/or pictures on websites.

Results

Figure 1 summarises the flow chart for the study. Table 1 and Figure 2 present the papers retrieved from the core journals. Feneck et al. adopted a very restrictive filter for paper types they included, excluding several publication types which are now regarded as mainstream academic outputs [1]. These include: systematic reviews; meta-analyses; mathematical modelling; case series (akin to observational trials); and surveys (now often conducted on a regional or national scale). Therefore, the data are arranged so that they can be compared directly with Feneck et al., and also to include these now-mainstream paper types. Moreover, whereas Feneck et al. did not find any relevant material in the eight additional non-anaesthetic journals examined, we obtained more data for 2017–2019 (Table 1; Fig. 2). Applying the same filter used by Feneck et al., the total number of publications has appeared to ‘level off’ in rate of decline since 2006. Including the paper types not previously incorporated and also including eight other journals slightly reverses the decline, but the overall publishing output remains at approximately half that in the late 1990s, using the restrictive Feneck et al. benchmark for comparison.

Table 2 presents the publications (across all 15 journals) by type. Secondary research, as we define it, constitutes the bulk (71%) of all UK research output.

Table 3 lists the number of papers associated with each centre, and the number of different individuals from that centre appearing as authors between 2017 and 2019. The centres are ranked according to their number

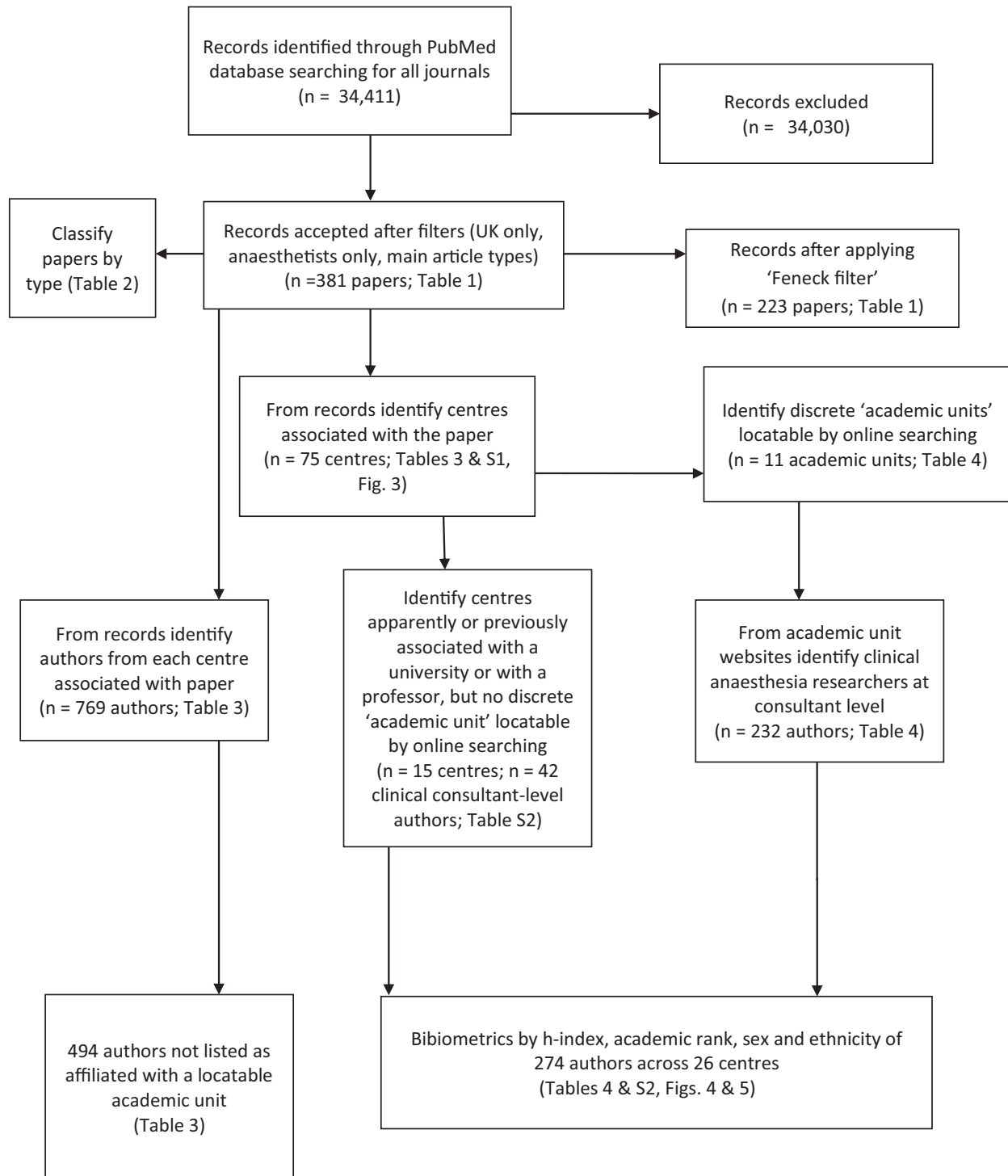


Figure 1 Flowchart of protocol for data retrieval, analysis and identification of key authors; search for publications in index journals 2017–2019.

of published papers (note that this exceeds the numbers in Table 1 because of authors from multiple centres being listed on the same papers). Online Supporting Information Table S1 lists centres that were associated

with just one paper. Figure 3 summarises these data geographically.

We located 11 centres (Table 4) in which an academic unit of anaesthesia – as we defined it – was readily locatable.

Table 1 Number of UK publications by year, and the totals. The data are presented to match the filter used by Feneck et al. and also to reflect the papers from the specialist and general journals. There were no UK anaesthesia papers in *NEJM*. Note that Feneck et al. missed two survey papers in *BMJ* and one randomised trial in *Lancet* for 1999; the data have been corrected in Figure 1 and other tables.

	n (to match Feneck et al. filter)				n (total)			
	2017	2018	2019	Total	2017	2018	2019	Total
<i>BJA</i>	17	23	17	57	27	34	27	88
<i>Anaesthesia</i>	28	23	22	73	43	35	43	121
<i>EJA</i>	3	0	3	6	4	1	8	13
<i>Anesthesiology</i>	5	3	3	11	7	3	4	14
<i>Anesth Analg</i>	4	6	4	14	5	11	6	22
<i>Acta Scand</i>	0	1	4	5	2	5	6	13
<i>CJA</i>	0	1	6	7	1	1	7	9
Subtotal (1)	57	57	59	173	89	90	101	280
<i>J Card Thor An</i>	5	6	0	11	7	13	0	20
<i>IJOA</i>	3	2	2	7	6	2	5	13
<i>Crit Care</i>	7	9	6	22	14	20	12	46
<i>Pain</i>	0	3	4	7	1	7	5	13
<i>Lancet</i>	0	1	0	1	0	2	2	4
<i>JAMA</i>	0	0	2	2	0	2	1	3
<i>BMJ</i>	0	0	0	0	1	0	1	2
<i>NEJM</i>	0	0	0	0	0	0	0	0
Subtotal (2)	15	21	14	50	29	46	26	101
Total	72	78	73	223	118	136	127	381

BJA, *British Journal of Anaesthesia*; *EJA*, *European Journal of Anaesthesiology*; *Anesth Analg*, *Anesthesia and Analgesia*; *Acta Scand*, *Acta Anaesthesiologica Scandinavica*; *CJA*, *Canadian Journal of Anesthesia*; *J Card Thor An*, *Journal of Cardiothoracic and Vascular Anesthesia*; *IJOA*, *International Journal of Obstetric Anesthesia*; *Crit Care*, *Critical Care*; *JAMA*, *Journal of the American Medical Association*; *BMJ*, *British Medical Journal*; *NEJM*, *New England Journal of Medicine*.

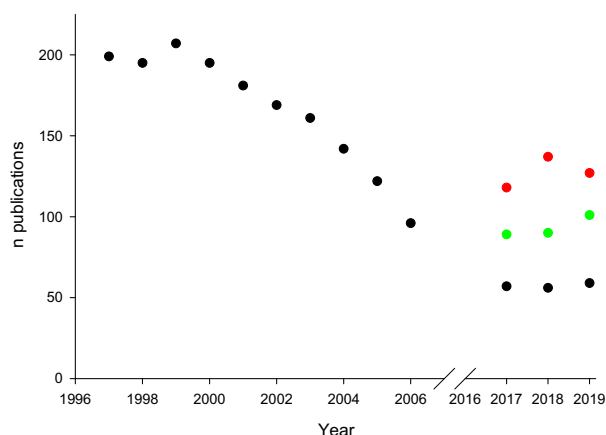


Figure 2 Publications by year. Data up to 2006 are plotted from the tables in Feneck et al. [1]. Using the same filter for publication type is shown in black circles; a more inclusive filter for the seven anaesthesia journals is shown in green circles; and a more inclusive filter for the seven anaesthesia and the eight general journals is shown in red circles.

The number of consultant anaesthetists in each academic unit ranges from 4 to 88, and the number (%) of professors in such units from 1 to 10 (~5–50%). The proportion of women varies from 0 to ~39%, and that of BAME staff from 0 to ~37%.

We also located 15 other centres (online Supporting Information Table S2) where there was a potential academic unit. It proved very difficult to search for anaesthetists within the websites of these centres, and this was only possible using various search strategies on staff lists to reveal a total of 42 names, including 24 professors, 8 women and 10 BAME staff.

The median h-index for all staff combined at the identified academic units in Table 4 (8 (3–17 [0–96])) was lower than for other centres in online Supporting Information Table S2 (18 (9–28 [1–54])), presumably because this latter group did not include a ‘tail’ of lower-productive, perhaps more junior, academics that is inevitable within a departmental structure. This tail is

Table 2 Types of paper by journal across all 3 years (%). There were no papers in *NEJM* (Table 1).

	Observational	Database	Clinical Trial	Systematic review/meta-analysis	Survey	Association	Animal/cell	Bench	Simulation	Physiology	Totals
<i>BJA</i>	19	10	9	11	7	15	10	2	3	2	88
<i>Anaesthesia</i>	24	18	22	7	21	9	0	11	6	3	121
<i>EJA</i>	5	2	2	0	2	0	0	1	1	0	13
<i>Anesthesiology</i>	2	2	2	2	0	0	3	0	3	0	14
<i>Anesth Analg</i>	6	5	2	2	2	0	1	4	0	0	22
<i>Acta Scand</i>	1	6	4	1	0	1	0	0	0	0	13
<i>CJA</i>	0	1	1	0	2	0	0	2	3	0	9
Subtotal (1)	57	44	42	23	34	25	14	20	16	5	280
<i>J Card Thor An</i>	10	4	1	4	1	0	0	0	0	0	20
<i>IJOA</i>	2	3	4	2	1	0	0	1	0	0	13
<i>Crit Care</i>	7	10	6	12	4	3	3	0	1	0	46
<i>Pain</i>	1	2	2	2	0	0	5	1	0	0	13
<i>Lancet</i>	1	0	2	1	0	0	0	0	0	0	4
<i>JAMA</i>	0	0	3	0	0	0	0	0	0	0	3
<i>BMJ</i>	0	0	1	1	0	0	0	0	0	0	2
Subtotal (2)	21	19	19	22	6	3	8	2	1	0	101
Total	78 (20%)	63 (17%)	61 (16%)	45 (12%)	40 (10%)	28 (7%)	22 (6%)	22 (6%)	17 (4%)	5 (1%)	381

BJA, British Journal of Anaesthesia; *EJA*, European Journal of Anaesthesiology; *Anesth Analg*, Anesthesia and Analgesia; *Acta Scand*, Acta Anaesthesiologica Scandinavica; *CJA*, Canadian Journal of Anesthesia; *J Card Thor An*, Journal of Cardiothoracic and Vascular Anesthesia; *IJOA*, International Journal of Obstetric Anesthesia; *Crit Care*, Critical Care; *JAMA*, Journal of the American Medical Association; *BMJ*, British Medical Journal; *NEJM*, New England Journal of Medicine.

evident in the h-score distribution across authors from all centres (Figure 4). Consistent with this notion, there was no marked difference in h-index of professors affiliated to identifiable academic units in Table 4 (26 (12–36 [1–96])) vs. those at other centres in online Supporting Information Table S2 (25 (18–29 [9–54])).

All except three of the very highly published anaesthetists (h-index > 35) are from identifiable academic units (Figure 5). This cut-off was chosen as the upper quartile for professorial h-scores from the 11 main academic units (Table 4). Overall, 116 (42.3% of all authors in Table 4 and online Supporting Information Table S2 combined) have h-index > 10. Notably, there are no women among the 16 most highly published (Figure 5) and women hold only 13 (18.6%) of professorial titles; their median h-index (22 (11–28 [5–32])) is similar to that of male professors (27 (13–36 [1–96])), n = 57). There are only four women who are also BAME; there are 11 BAME of 70 male professors (15.7%).

The notes appended to online Supporting Information Table S2 also list three centres (Newcastle, Belfast, Middlesbrough) that were identified in the original Pandit Report as having had an academic department, but no anaesthetists are currently locatable in their university staff listings. This is despite Newcastle appearing to have access to an Academic Clinical Fellowship (ACF) programme (Table 3), and Belfast having 20 individuals contributing to

authorship (Table 3); what can be found on the Belfast site is only the obituaries of some anaesthetists (<https://daro.qub.ac.uk/sslpage.aspx?pid=295&txtSearch=anaesthesia>).

Discussion

These data illustrate the academic capacity of UK anaesthesia, in terms of publication outputs (~124 papers per year in the index journals; Table 1), predominant output type (secondary research; Table 2), infrastructure (11 identifiable academic units; Table 4), and the number of research-active staff (274 authors affiliated with centres, Tables 4 and online Supporting Information Table S2; 116 of whom have a h-index > 10 Figure 3).

Another finding is that the decline in the UK anaesthesia publishing highlighted by Feneck et al. [1] has been halted, but not reversed (Fig. 1). Before we consider whether this situation is satisfactory and how these data could inform strategy, we will discuss the strengths and limitations of the analysis.

Contextual background of the analysis

All bibliometric analyses can err in data retrieval: we found and corrected small errors in Feneck et al.'s previous work [1] (Table 1). Confining the analysis to just 15 journals helped comparison with their previous data, but might under-represent outputs. For example, we randomly

Table 3 Centres from which publications originated and number of different author names associated with those papers (for years 2017–19). The last column shows whether the centre has advertised or appears to have access to an ACF post.

	Papers associated with centre (n)	Authors names from that centre listed on a paper (n different)	Academic Clinical Fellowship (ACF)
UCL	69	82	Yes
Imperial	54	57	Yes
KCL	35	56	Yes
Cambridge	35	52	Yes
Barts	34	48	Yes
Oxford	27	17	Yes
Cardiff ^a	22	23	Yes
Edinburgh	21	40	Yes
Manchester	21	32	Yes
Bristol	21	28	Yes
Nottingham	21	27	Yes
St George's	19	18	
Birmingham	18	19	Yes
Southampton	18	14	Yes
Leeds	17	10	
Bath	16	13	
Sheffield	12	13	
Liverpool	12	22	
Glasgow	10	20	
Swansea	9	7	
Torquay	9	5	
Lancaster	6	3	Yes
Plymouth	5	12	Yes
Newcastle	8	8	Yes
Aberdeen	7	5	Yes
Dundee	6	13	
UHCW	4	9	Yes
Bournemouth	4	8	
Belfast	3	20	
Surrey	3	5	
Middlesbrough	3	6	
Norwich	3	2	
Leicester	3	2	Yes
York	2	5	
Burton	2	3	
Bangor	2	3	
Hull	2	2	
Wansbeck	2	2	

(continued)

3 (continued)

	Papers associated with centre (n)	Authors names from that centre listed on a paper (n different)	Academic Clinical Fellowship (ACF)
Wishaw	2	2	
Frimley	2	2	
Milton Keynes	2	2	
Brighton	2	1	
Southend	2	1	
Total	606^b	769^c	19

UCL (University College London, which includes Great Ormond Street and the Royal Free hospitals); Barts (St Bartholomew's Hospital, which is part of Queen Mary University, and includes the London Hospital and the William Harvey Research Institute); KCL (King's College London (previously Guy's, King's, St Thomas')); UHCW (University Hospitals Coventry & Warwickshire). Imperial includes the Royal Brompton. ACF data from <https://www.nihr.ac.uk/documents/acf-unfilled-posts-2020/22381>; and [http://www.scotmt.scot.nhs.uk/specialty/scottish-academic-training-\(screds\).aspx](http://www.scotmt.scot.nhs.uk/specialty/scottish-academic-training-(screds).aspx), accessed 20/01/2020).

^aIncludes all hospitals of the Cardiff and Vale University Health Board.

^bIncludes papers from online Supporting Information Table S1.

^cIncludes 39 authors from online Supporting Information Table S1.

sampled publication records of 3 of the 16 very highly cited authors in Figure 5 and found them to have, respectively, 4/16, 5/13 and 8/42 outputs in non-index journals (19–38%) between 2017 and 2019. This in part might explain the apparent under-representation of basic science work (Table 2) as this is often directed to specialised science journals. In turn, this might skew the data as presented for certain academic centres, if they target their publishing outside the 15 index journals, including those primarily in surgery, or quality and safety. A previous editorial highlighted the growth of anaesthesia journals [2], and this even applies to high impact general journals like the *Lancet*, which now has spin-offs like *Lancet Neurology*, etc; we did not sample all these 'sister journals'. Our approach, like that of Feneck et al., was weighted against critical care journals, which have grown in number and quality. That said, Ausserer et al.'s international bibliometric analysis reported that the UK published ~100 original papers per year between 2001 and 2015 [11]. This suggests reasonable data capture within our analysis.

Individual citation metrics are subject to dynamic variation, so at best the data in Tables 4 and online Supporting Information Table S2 are a snapshot; only the authors themselves really know their publication

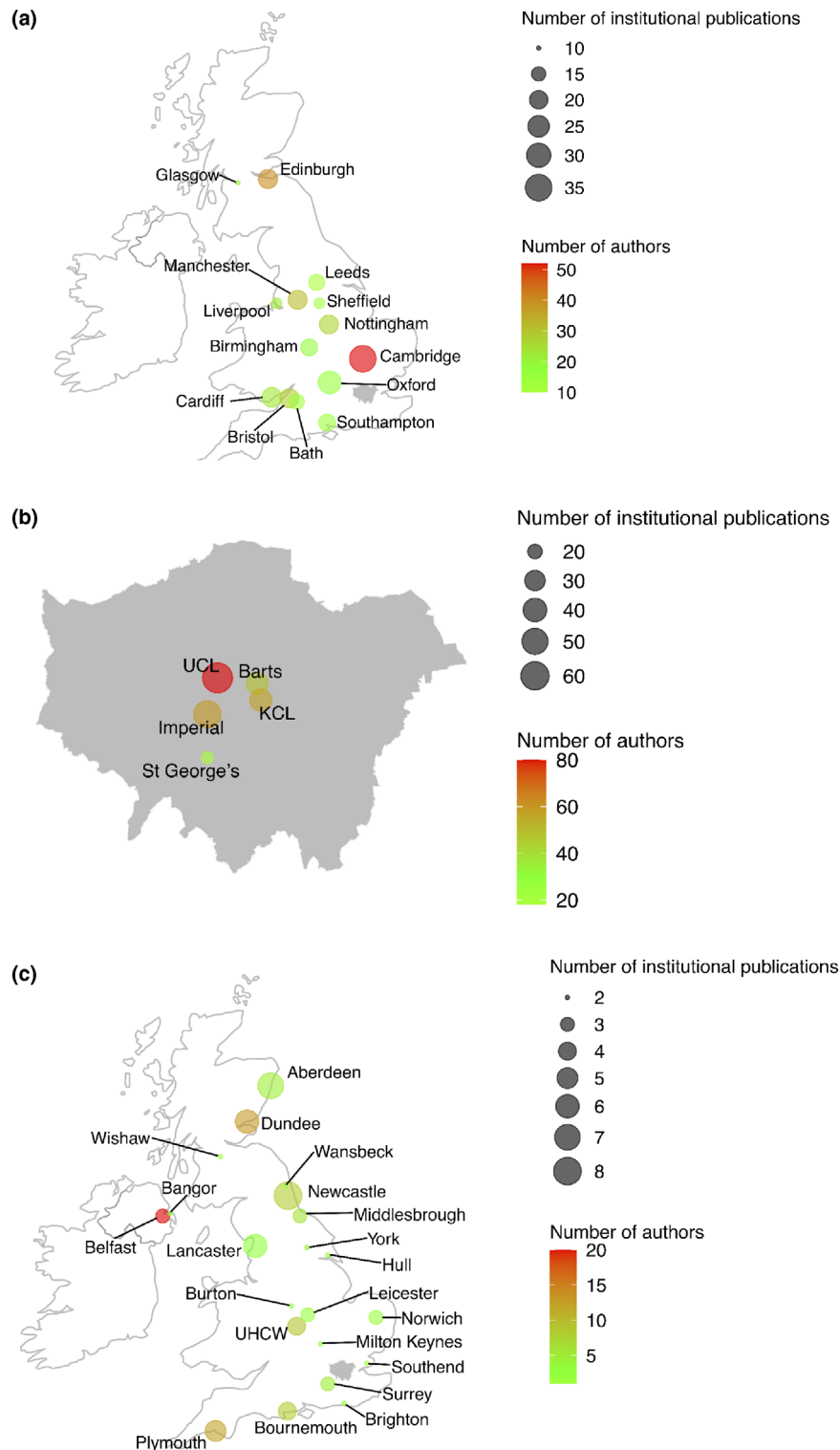


Figure 3 (a) Geographical distribution of publications (excluding London). The size of the bubble represents the number of publications associated with a centre (data shown for centres with >10 publications); the graded colour scheme represents the number of authors from that centre (data from Table 3). (b). Geographical distribution of publications for London centres. (c). Geographical distribution of publications for centres (excluding London), for centres with <10 publications.

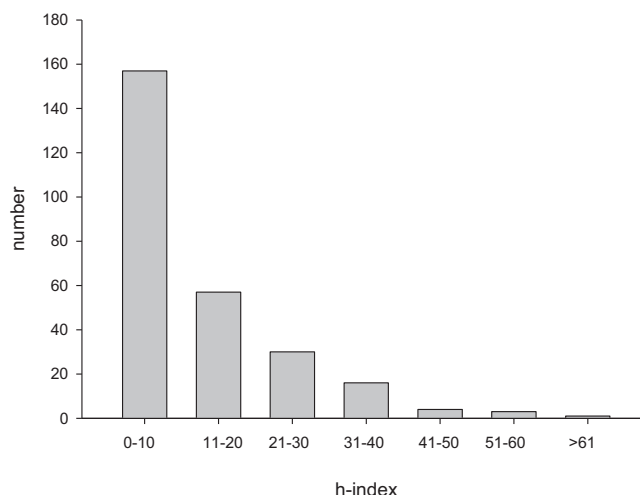


Figure 4 Distribution of h-index for all authors in Table 4 and Table S2.

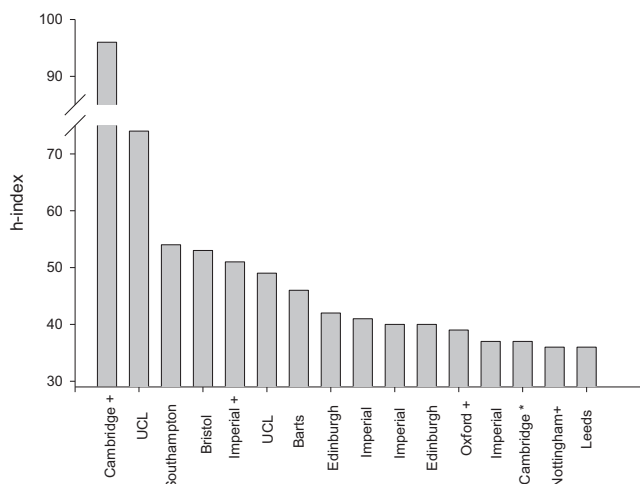


Figure 5 The h-index of 16 very highly cited authors (those with h-index > 35), identified by their unit, ranked in order. All are male; there is only one without a professorial title (*) and 4 are BAME (+). UCL, University College London.

record and this can change quite rapidly with a significant publication. Authors with very common names are difficult to search, even after applying filters by affiliation. ORCID (Open Researcher and Contributor ID; www.orcid.org) was not searched, but not all authors use this or link every publication to it. We confined the data in Table 4 and online Supporting Information Table S2 to authors affiliated to an academic centre; some in the remaining group of 494 authors may have comparable publication metrics that we have overlooked. Despite its known limitations, our use of h-index was probably justified [13, 14].

Another potentially confounding factor is the changing nature of authorship [15]. The acceptance of

'collaborators' as primary authors in PubMed has led to some huge authorship lists. By confining our samples to names published under the main paper title led to a more manageable dataset, but in turn may have wrongly under-estimated true activity. The rise of trainee networks [16, 17] sometimes results in wide authorship, or none if the paper is assigned to the collaborative [18]. This is akin to the famous French mathematicians who published separately, but under the single fictitious name 'Nicholas Bourbaki' [19].

Only papers associated with medically qualified anaesthetists were included in Tables 1 and 2, and only from consultants in Table 4 and online Supporting Information Table S2, regardless of whether they were

Table 4 Centres which have an internet-searchable anaesthesia academic group. The first column gives the name we use in this paper (see online Supporting Information Table S3 for the websites); the second column lists the total number of listed consultants detailed as having an academic interest or publication record (and as % of the total for all units); next is the n (%) of those with a professorial title; the last two columns respectively show the n (%) of female and BAME consultants. The UCL listing includes Great Ormond Street, the Bloomsbury Unit and the Royal Free; Imperial includes the Royal Marsden, the Royal Brompton and Stanmore. *includes one Reader; **includes two Readers. All of these were identified in the Pandit Report (2006) as having an academic department. Values are number (proportion) or median (IQR [range]).

Centre	Total consultant level clinical anaesthetists, n (% of grand total) h-index	Professors, n (% of total n in that unit) h-index	Female, n (% of total n in that unit) h-index	BAME n (% of total n in that unit) h-index
UCL	88 (37.9%) 4 (2–8 [1–74])	10 (11.4%) 23 (13–30 [2–74])	34 (38.6%) 3 (1–6 [1–29])	23 (26.1%) 4 (2–6 [1–28])
Imperial	29 (12.5%) 12 (5–24 [1–51])	7 (24,1%)* 37 (29–41 [20–51])	6 (20.6%) 8 (5–21 [3–22])	10 (34.5%) 8 (4–22 [1–51])
Cambridge	29 (12.5%) 11 (4–22 [1–96])	3 (10.3%) 34 (16–81 [10–96])	4 (13.8%) 3 (1–5 [1–6])	7 (24.1%) 14 (10–30 [4–96])
Barts (William Harvey Institute, Queen Mary, London)	4 (1.7%) 24 (21–26 [20–46])	2 (50%)* 36 (26–46 [26–46])	0	0
KCL	19 (8.2%) 4 (1–12 [1–22])	1 (5.2%) 20 (20–20 [20–20])	5 (26.3%) 3 (2–8 [1–20])	7 (36.8%) 9 (2–11 [1–22])
Nottingham	8 (3.4%) 17 (11–26 [1–36])	5 (62.5%) 25 (7–29 [1–36])	0	2 (25.0%) 19 (1–36 [1–36])
Oxford	11 (4.7%) 12 (8–23 [4–39])	5 (45.4%) 14 (25–30 [12–39])	3 (27.3%) 8 (5–9 [4–9])	1 (9.1%) 39 (39–39 [39–39])
Edinburgh	12 (5.2%) 15 (8–27 [4–42])	5 (41.7%)** 26 (16–41 [9–42])	4 (33.3%) 8 (7–18 [6–26])	2 (16.7%) 12 (9–15 [9–15])
Sheffield	7 (3.0%) 10 (5–13 [4–31])	1 (14.3%) 31 (31–31 [31–31])	2 (28.6%) 4 (4–4 [4–4])	1 (14.3%) (4–4 [4–4])
Liverpool	13 (5.6%) 6 (1–14 [1–32])	2 (15.4%)* 22 (12–32 [12–32])	2 (15.4%) 1 (1–1 [1–1])	1 (7.7%) 1 (1–1 [1–1])
Glasgow	12 (5.2%) 8 (3–10 [1–16])	5 (41.7%) 8 (7–9 [5–13])	4 (3.3%) 6 (4–12 [2–16])	1 (7.7%) 16 (16–16 [16–16])
Totals (11 academic units)	232 8 (3–17 [1–96])	46 (19.7%) 26 (12–36 [1–96])	64 (27.5%) 4 (2–8 [1–29])	55 (24.0%) 6 (3–16 [1–96])

BAME, black, Asian and minority ethnic; UCL, University College London; KCL, King's College London.

embedded in an NHS or university setting. There is no doubt that non-anaesthetist basic scientists have played – and continue to play – essential leadership roles in anaesthesia. However, the very purpose of this work was to identify the *clinical* academic capacity. A separate analysis is necessary to identify the different ways in which non-clinical researchers are contributing to academic anaesthesia, and the different ways they are embedded (contractually or otherwise) within academic anaesthesia units (where such exist). Moreover, we made no distinction between 'academics' and 'clinicians', not least because we did not know anything about their employment contracts (e.g. university vs. NHS) or detailed job plans (balance of clinical vs. non-clinical duties). The purpose of this analysis was not to determine whether universities are employing

anaesthetists, but simply to identify which anaesthetists are publishing, to what extent, and where they are located.

Our broad definition of 'academic unit' was based only on internet presence. We do not know the extent to which, if at all, any of the units listed in Table 4 are embedded within a university structure, how they are funded or supported with administrative staff, etc.

This wide embrace led us to include several NHS departments as part of a geographical entity where in reality, there may be no links at all between NHS and university groupings in the centres listed in Table 4. Notably in London, but also elsewhere, medical schools have undergone several re-organisations over the years and authors have used several affiliations at different times (and sometimes concurrently). For example, the university

institution of King's College London (referred to in our Tables 3 and 4 as KCL), was previously known as Guy's, King's and St Thomas' (GKT). From the perspective of individuals based at the individual hospitals of Guy's and St Thomas' NHS Foundation Trust or even King's College Hospital (and other affiliated hospitals), KCL may not be an entity they identify with, yet we grouped all papers from these hospitals under this banner. The University College London (UCL) department appears to embrace Great Ormond Street (GOS) and the Royal Free hospital, but this is apparent only from the main academic website (<https://www.ucl.ac.uk/anaesthesia/people>); most papers from these other centres do not in fact state UCL as an affiliation.

Although we cannot locate an internet presence for units in online Supporting Information Table S2, these may include robust departments of anaesthesia within a clear university structure, although this would seem incongruous. Further detail about these academic units – if they exist – might have been obtained by direct contact. However, that would be to miss the point that retrieving this information should be undemanding.

For individual metrics, we did not distinguish between different categories of professor (e.g. full, associate, assistant, visiting, etc); this was not always evident. Also, we did not know whether an 'associate' at one centre was equivalent to, say, an 'assistant' at another, especially when both categories were not common to all. 'Reader' is a uniquely British term still used by a few (corresponding to 'associate professor'), and we included it in the wider professor category, as marked in Tables 4 and online Supporting Information Table S2). Moreover, we regarded specialty professors as equivalent [20]. Thus 'professors' represent ~25% of all authors in Tables 4 and online Supporting Information Table S2. Our data are useful in this regard in setting objective benchmarks against which to make professorial appointments. The low h-index of some professors might represent recognition given for administration or teaching, but it would be surprising – if not an injustice – for any anaesthetist with a h-index > 36 not to be a professor, since this represents the upper quartile threshold (Table 4). The use of specialty professor awards using such benchmarks is especially strategically important, where universities have failed to offer the due recognition [20].

The overall proportion of female authors affiliated to academic centres (~26%; online Supporting Information Table S2) is a little lower than the reported proportion of female consultants (32%) [21]. However, their median h-index 4 (2–9 [1–32]) is less than half that of (10 (4–20 [1–96])) [22]. It is a shortcoming that the Royal College of

Anaesthetists does not appear to collect data on ethnicity [21]. Government data indicate that 39% of consultants are BAME; assuming a similar proportion in anaesthetics, BAME representation in academic centres is much lower (~24%; Tables 4 and online Supporting Information Table S2). Our data should be interpreted with some caution. Ultimately, ethnicity and gender are self-declared identities, ascertainable only by survey [23]. However, preliminary screening by name or appearance, is argued to be valid and ethical as a means to stimulate and justify further research [24].

Is the situation satisfactory?

There are some 7,422 UK anaesthetic consultants [21, 25]. The figure of 769 authors across 3 years of publishing (Table 3) means that at most ~10% undertake some publishing; of these, 274 (3.7%) are affiliated to any type of academic centre, and 116 (1.6%) have a h-index > 10, indicating they are regularly and actively publishing. This does not seem like an over-investment in research.

Notwithstanding the possibility it is being published elsewhere, the dearth of primary research in the index journals should be a concern. All research has value, but secondary research like meta-analysis requires the primary research in the first place. Observational or association studies require confirmation of hypotheses using more direct approaches. Primary basic science studies have the strategic advantage of sustaining platform technologies (e.g. cell or brain imaging, electrophysiology, genomic sequencing, etc.) upon which a whole range of other research can be conducted, especially in collaboration with other disciplines, and in which students can learn technical transferrable skills. There seems a danger that while UK anaesthesia appears to have undoubted strengths in analysis of datasets, it is weak in 'hands-on' laboratory and clinical research skills. This raises the dilemma of whether the specialty should play to existing strengths, or invest in acquiring different, new skills. The latter is termed 'diversification' in strategic terms and used by businesses to expand markets [26]. Even if apparent deficiencies in primary (basic science) research are explained by anaesthesia journal publishing strategies, this in turn is a concern. If anaesthetists generally read anaesthesia journals, and if these publish mainly secondary research (Table 2), then how can trainees ever encounter primary research?

Of course, secondary research may have flourished only because of the hurdles of undertaking primary research. The increasing burden of requirements for ethical and NHS research governance permissions,

sponsor approval, data monitoring and trial steering committees, and for data deposition on expensive databases and analysis by an accredited statistician, etc, may all be beyond the capacities of many NHS departments. Hence the need for academic units with the necessary infrastructure; yet the resulting vicious cycle is that with fewer academic centres, there is less primary research, and so on [27].

Now almost 10 years ago, Moppett and Hardman presented a bibliometric classification of all the UK academic departments, readily identifying 23 discrete units using the Pandit Report [10]; more than double the number we can now locate (Table 4). They reported on 104 affiliated researchers – which included non-clinical staff – and estimated a median h-index of 13, with a maximum of 60. Table 4 and Figure 5 indicate that individuals appear to perform well, but this individual excellence may not be a basis for sustainable national strategy.

We did not investigate academic training, but Table 3 lists centres that appear to support Academic Clinical Fellows (ACFs). Across all specialties there appear to be ~ 263 ACF posts across England, but just 15 are listed as being open to – but not reserved for – anaesthetic or intensive care medicine applications (a further four in 'acute specialties'). Therefore, the annual number of anaesthesia ACF appointments is unknown but probably very small. The voluntary database of the National Institute of Academic Anaesthesia (NIAA; at <https://www.niaa.org.uk/researchDb> Browser; accessed 25/03/2020) lists ~ 116 names. Several are retired anaesthetists, some are nurses, basic scientists and study co-ordinators, and only four appear to be ACFs, some now clearly consultants. There is clearly a need for improved datasets. We know that several trainees undertake higher degrees outwith an ACF programme, but again information is sparse.

How could these data inform strategy?

The 'resource-based view' of strategy is a recognised managerial framework used to encourage organisations to understand their core competencies and capacities to achieve sustainable competitive advantage [28]. Generating a 'capacity map' is an essential part of this process. The resultant strategy involves a mix of playing to existing strengths and/or filling gaps [29]. Our academic capacity map of UK anaesthesia is the first step in this resource-based approach (see Appendix A).

National databases of academic training are important, as is consultant-level information. Authors should seek to correct the record we present here – not by simply corresponding with us – but more importantly by exerting

pressure on their own departments to improve website presentation, and on the key anaesthetic organisations to institute an ongoing database of researchers who form the academic community.

Broadly, two approaches represent the extremes of academic growth planning. In 'survival of the fittest' the specialty passively offers grant funding; individuals or departments compete, with the strongest surviving. The Pandit Report challenged this 'laissez faire' approach but it has not succeeded in this respect, if judged by the number of remaining academic units (Table 4) and publication outputs (Table 1). 'Survival of the fittest' possibly results in stronger individual departments, but at the cost of overall national decline and threat to critical mass [30].

An alternative is a 'planned economy' with investments targeted to maximum gain. Where funding is limited, a perennial dilemma is how best to judge the targeting mechanism, and this is where our data may help. The secondary research characteristic of UK activity is advantageously relatively cheap (apart from academic time, little equipment or consumables are required). If led by NHS departments or specialist societies, high publication outputs could be achieved with modest, targeted investment. Investments directed to academic units are cost-effective in a different way; their existing infrastructure can add value through shared resources or equipment, or staff who could work flexibly around several projects. Thus, primary and basic science funding could be beneficially targeted here. Moreover, these centres reliably offer a suitable environment for academic training.

This theme of academic training could bring these academic centres closer together. By distributing academic training posts equitably over time (along with the funding they carry), 'planned careers' are possible. For example, through information sharing and identifying in advance the different opportunities as they arise, a trainee could undertake a primary higher research degree in one centre, postdoctoral training in another, and obtain a substantive academic position in a third. Because these cycles would occur in equitable rotation, all centres would benefit from the dividends over time, making use of favourable local circumstances as they arise in different places.

Conclusion

The details presented in this paper need to be refined by nationally-led data collection, as a comprehensive 'capacity map' of academic anaesthesia. This is a prerequisite for developing any strategic initiative (summarised in Appendix A). With so few key researchers nationally and

fewer than a dozen discrete academic units, our results indicate that the task seems achievable.

Acknowledgements

JP is an elected Member of Council, Royal College of Anaesthetists. The views are personal and not reflective of the views or policy of that organisation. KE is an Editor for *Anaesthesia*. We thank Dr DJN Wong for assistance with Figure 3 (map). No external funding or other competing interests declared.

References

1. Feneck RO, Natarajan N, Sebastian R, Naughton C. Decline in research publications from the United Kingdom in anaesthesia journals from 1997 to 2006. *Anaesthesia* 2008; **63**: 270–5.
2. Pandit JJ. Anaesthetic research in the United Kingdom: publishing or perishing? *Anaesthesia* 2008; **63**: 225–7.
3. Pandit JJ. *A National Strategy for Academic Anaesthesia*. London: Royal College of Anaesthetists, 2005. https://www.niaa.org.uk/downloads/Academic_full.pdf (accessed 20/01/2020).
4. Pandit JJ. The national strategy for academic anaesthesia. A personal view on its implications for our specialty. *British Journal of Anaesthesia* 2006; **96**: 411–4.
5. Pandit JJ. Future opportunities and challenges in academic anaesthesia in the United Kingdom: a model for maintaining the scientific edge. *Current Opinion in Anaesthesiology* 2010; **23**: 159–66.
6. Charlesworth M, Klein AA, White SM. A bibliometric analysis of the conversion and reporting of pilot studies published in six anaesthesia journals. *Anaesthesia* 2020; **75**: 247–53.
7. El-Boghdady K, Docherty AB, Klein AA. Analysis of the distribution and scholarly output from National Institute of Academic Anaesthesia (NIAA) research grants. *Anaesthesia* 2018; **73**: 679–91.
8. Chen SY, Wei LF, Ho CM. Trend of academic publication activity in anesthesiology: a 2-decade bibliographic perspective. *Asian Journal of Anesthesiology* 2017; **55**: 3–8.
9. Pagel PS, Hudetz JA. Scholarly productivity and National Institutes of Health funding of Foundation for Anesthesia Education and Research grant recipients: insights from a bibliometric analysis. *Anesthesiology* 2015; **123**: 683–91.
10. Moppett IK, Hardman JG. Bibliometrics of anaesthesia researchers in the UK. *British Journal of Anaesthesia* 2011; **107**: 351–6.
11. Ausserer J, Miller C, Putzer G, et al. International publication trends originating from anaesthetic departments from 2001 to 2015. *Anaesthesia* 2017; **72**: 1243–50.
12. Kotsemir M, Shashnov S. Measuring, analysis and visualization of research capacity of university at the level of departments and staff members. *Scientometrics* 2017; **112**: 1659–89.
13. Pandit JJ. Measuring academic productivity: don't drop your 'h's!. *Anaesthesia* 2011; **66**: 861–4.
14. Pagel PS, Hudetz JA. H-index is a sensitive indicator of academic activity in highly productive anaesthesiologists: results of a bibliometric analysis. *Acta Anaesthesiologica Scandinavica* 2011; **55**: 1085–9.
15. Sheikh A. Publication ethics and the research assessment exercise: reflections on the troubled question of authorship. *Journal of Medical Ethics* 2000; **26**: 422–6.
16. Clark T. The RAFT Committee. Research and Audit Federation of Trainees (RAFT): uniting trainees to undertake national projects. *Royal College of Anaesthetists Bulletin* 2014; **58**: 54–5.
17. Dowswell G, Bartlett DC, Futaba K, Whisker L, Pinkney TD. How to set up and manage a trainee-led research collaborative. *BMC Medical Education* 2014; **14**: 94.
18. STARSurg Collaborative. Association between peri-operative angiotensin-converting enzyme inhibitors and angiotensin-2 receptor blockers and acute kidney injury in major elective non-cardiac surgery: a multicentre, prospective cohort study. *Anaesthesia* 2018; **73**: 1214–22.
19. Dieudonné JA. Should we teach "modern" mathematics? An affirmation from a founder of Bourbaki of the principles of the new curricula in mathematics. *American Scientist* 1973; **61**: 16–9.
20. Pandit JJ, Kapila A, O'Sullivan E. Specialty-appointed professors of anaesthesia: a solution to the problem of marginalisation of our specialty in national reports and enquiries. *Anaesthesia* 2012; **67**: 73–4.
21. Royal College of Anaesthetists. *Workforce Data Pack 2018*. London: RCOA, 2018.
22. Pagel PS, Freed JK, Lien CA. Gender differences in authorship in the journal of cardiothoracic and vascular anesthesia: a 28-year analysis of publications originating from the United States, 1990–2017. *Journal of Cardiothoracic and Vascular Anesthesia* 2019; **33**: 593–9.
23. Lin SS, Kelsey JL. Use of race and ethnicity in epidemiologic research: concepts, methodological issues, and suggestions for research. *Epidemiologic Reviews* 2000; **22**: 187–202.
24. Jones CP. Invited Commentary: "Race", racism, and the practice of epidemiology. *American Journal of Epidemiology* 2001; **154**: 299–304.
25. Sury MR, Palmer JH, Cook TM, Pandit JJ. The state of UK anaesthesia: a survey of National Health Service activity in 2013. *British Journal of Anaesthesia* 2014; **113**: 575–84.
26. Ansoff I. Strategies for diversification. *Harvard Business Review* 1957; **35**: 113–24.
27. Bayenet B, Feola C, Tavernier M. Strategic management of universities: evaluation policy and policy evaluation. *Higher Education Management* 2000; **12**: 65–80.
28. Barney J. Firm resources and sustained competitive advantage. *Journal of Management* 1991; **17**: 99–120.
29. Suter E, Lait J, Macdonald L, et al. Strategic approach to building research capacity in inter-professional education and collaboration. *Healthcare Quality* 2011; **14**: 54–60.
30. Winyard PJD, Cass HD, Stephenson TJ, Wilkinson AR, Olver RE. Developing critical mass and growing our own academics. *Archives of Diseases of Childhood* 2006; **91**: 1027–9.

Supporting Information

Additional supporting information may be found online via the journal website.

Table S1. Centres which had just one paper during 2017–2019.

Table S2. Details of units that appear to have academic anaesthetists associated with them, but no discrete academic unit.

Table S3. Further detail for Table 4.

Appendix A. Proposed key strategy initiatives informed by the data

- 1** Centres that regard themselves as academic units of anaesthesia should maintain up-to-date websites detailing affiliated staff, their areas of interest and key bibliometric data;
- 2** Academically active individuals should regard it as a responsibility to maintain their own records on these databases/websites (and usefully employ it for their annual appraisals);
- 3** National anaesthesia organisations (e.g. Royal College of Anaesthetists or National Institute for Academic Anaesthesia, (NIAA)) should maintain a central database of research-active anaesthetists – and the named academic unit(s) they are affiliated to – especially a register of academic trainees (those in Academic Clinical Fellow and Clinical Lecturer programmes, and those undertaking higher degrees outwith these programmes);
- 4** These databases and websites should present data on sex and ethnicity, among other protected characteristics, so that equality and diversity can be monitored;
- 5** These databases should, separately, include non-medically qualified staff and non-anaesthetists closely involved in or leading anaesthesia research;
- 6** The leading academic units should consider collaborating on 'planned academic careers': organising academic training at national level, across all the training grades, over time offering higher degree and postdoctoral opportunities;
- 7** The aggregated national-level bibliometric data can be used to inform academic promotions to professor and other ranks; specialty-appointed professor awards should be used to recognise anaesthetists who meet the threshold criteria;
- 8** Specialty grants (e.g. via NIAA) could be advantageously managed across two broad themes: secondary research and primary research, thus more transparently ensuring there is an appropriate balance between the two types of research approaches;
- 9** Anaesthesia journals should analyse and reflect on the balance of secondary vs. primary research (especially in the basic sciences) that is published, with a view to considering how they might encourage the latter;
- 10** Non-university centres with academically active individuals should support their academic progress and, where critical mass justifies it, consider forming an academic unit. Such units should be formally recognised as such by national anaesthetic organisations (e.g. NIAA), especially where they lack connection to a local university.

Next Generation SedLine® Brain Function Monitoring

Featuring an Enhanced Patient State Index for Adult and Pediatric Patients



A More Complete Picture Starts with More Complete Data

Next Generation SedLine:

- > Features an enhanced processed EEG parameter, the Patient State Index (PSi), with less susceptibility to EMG interference and improved performance in low power EEG cases
- > Offers a Multitaper Density Spectral Array (DSA), which may improve visibility of EEG features
- > Helps clinicians monitor the state of the brain under anaesthesia with bilateral data acquisition and four leads of electroencephalogram (EEG) signals

Discover SedLine



www.masimo.co.uk/sedline

© 2021 Masimo. All rights reserved.

For professional use. See instructions for use for full prescribing information, including indications, contraindications, warnings, and precautions.

