CE: D.C.; ANNSURG-D-21-01390; Total nos of Pages: 9;
ANNSURG-D-21-01390

ORIGINAL ARTICLE

Surgical Performance Anxiety and Wellbeing Among Surgeons

A Cross-sectional Study in the United Kingdom

AQ1 *Robert Miller, MRCS,*†✉ Matthew Hotton, DClinPsy,*‡ Aaron Williamon, PhD,§¶ Roger Kneebone, PhD,** Tim Goodacre, FRCS (Plast),†† and James K. K. Chan, FRCS(Plast)*†††‡‡§§*

Objective: This national cross-sectional study aims to establish the prevalence and potential impact of performance anxiety among surgeons and investigate its association with psychological traits and wellbeing.

Summary and Background Data: Despite a growing awareness that human factors, non-technical skills and wellbeing in healthcare affect patient outcomes, an area that has remained unexplored is SPA.

Methods: A prospectively registered, cross-sectional study using mixed methods was conducted across the United Kingdom. Data captured included demographics, surgical specialty, trait anxiety, trait perfectionism, SPA, and surgical perfectionism scores. Wellbeing was assessed using The Short Warwick-Edinburgh Mental Wellbeing Scale, whereas qualitative data were collected regarding surgeons' experiences of SPA.

Results: A total of 631 responses were collected. Mean age was 41·2 years and mean surgical experience 15·3 years. A total of 62% were male and 52% of consultant grade. A total of 100% felt that SPA affected surgeons, with 87% having experienced it themselves. A total of 65% reported SPA negatively impacted surgical performance and 96% felt SPA negatively impacted surgeons' wellbeing. Male surgeons reported significantly better wellbeing than female surgeons. Surgeons with SPA reported significantly worse wellbeing compared with surgeons who did not experience SPA. Surgeons in general experienced significantly lower mental wellbeing compared with population norms. Thematic analysis highlighted a reticence to share SPA openly and need for cultural change.

Conclusions: Surgical performance anxiety is a very common and significant challenge among surgeons across all specialties at all levels of experience in the United Kingdom. It is perceived by surgeons to affect surgical performance adversely and is associated with worse psychological wellbeing. A more open culture of sharing and acknowledgment has been identified to be beneficial.

Keywords: anxiety, perfectionism, surgical performance anxiety, surgical performance, well-being

(*Ann Surg* 2021;xx:xxx–xxx)

The psychological profile of surgeons, and their wellbeing, may impact both their ability to operate and patient outcomes.[1,2] Despite a growing awareness of the importance of human factors in surgery,[2] there is a paucity of research into the psychology of surgery and psychomotor skills, particularly with regards to performance anxiety (PA). Anxiety is an adaptive emotion, which occurs under conditions of perceived or actual threat. It results in somatic, cognitive and autonomic responses that can adversely impact the cognitive and procedural performance of an individual[3,4] and their attentional control.[5] PA refers to a specific form of anxiety manifested during the performance of a task under perceived, or actual, evaluation by others.[3,6] It ranges from an exaggerated anxiety response to an incapacitating response and panic, colloquially referred to as "stage fright."

PA has been studied in other settings, most notably among professional musicians[7–9] and athletes,[6] in whom it has been associated with poor performance.[10] Recently, parallels with anxiety experienced by surgeons have been proposed and the concept of PA in surgery introduced.[3,11–13] Although other performance-related responses such as stress[1,14] have been investigated in a surgical context, a comprehensive understanding of performance-related anxiety, and its impact on performance, is lacking. Individual differences in psychological variables may account for variation in the degree of PA experienced,[8] and provide an explanation for why individuals respond differently to the same levels of physiological arousal and external stressors.[3,15] Psychological traits previously implicated in PA, and therefore, warranting investigation, include trait anxiety and perfectionism.[3,8,16]

In modern healthcare systems, there has been greater recognition of psychological wellbeing and its role in burnout among doctors.[17] A deeper insight into relevant psychological traits will allow identification of both potentially modifiable risk factors, and those who may benefit from support. This is especially important in the light of the wide psychological impact on healthcare professionals of the coronavirus disease 2019 (COVID-19) pandemic.[18]

This cross-sectional study aims to establish the prevalence, nature and potential impact of PA in surgeons. Furthermore, it aims to investigate some of the pertinent psychological traits of surgeons' and their impact on surgical performance anxiety (SPA), and surgeons' wellbeing.

METHODS

Design

A cross-sectional mixed methods study design was used, incorporating anxiety, perfectionism and wellbeing scores with

AQ2 From the *Surgical Psychology and Performance Group, U.K.; †Department of Plastic and Reconstructive Surgery, St George's Hospital NHS Trust, London, U.K.; ‡Oxford University Hospitals NHS Trust, U.K.; §Centre for Performance Science, Royal College of Music, London, U.K.; ¶Faculty of Medicine, Imperial College London, U.K.|| Centre for Engagement and Simulation Science, Chelsea & Westminster Hospital, London, U.K.; **Division of Surgery, Imperial College London, U.K.; ††Nuffield Department of Surgery, Oxford, U.K.; ‡‡Department of Plastic and Reconstructive Surgery, Buckinghamshire Healthcare NHS Trust, U.K.; and §§Nuffield Department of Orthopaedics, Rheumatology, and Musculoskeletal Science, University of Oxford, U.K.

✉robmiller90@gmail.com.

The Association of Surgeons in Training & The Centre for Performance Science. This project received funding in the form:

- The Association of Surgeons in Training "Training and Research" Grant 2018. This grant paid for the use of the on-line survey platform (www.surveyhero.com) for the duration of the study.
- The Centre for Performance Science, Royal College of Music, London, U.K. The Centre of Performance Science funded the license fee for use of the State-Trait Anxiety Inventory (STAI).

No parties were paid to write this article.

The dataset generated during and/or analyzed during the current study are not available. This is as per the study ethics submission to ensure individual responses are kept anonymous.

AQ3 The authors report no conflicts of interest.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's web site (www.annalsofsurgery.com).

Copyright © 2021 Wolters Kluwer Health, Inc. All rights reserved.

ISSN: 0003-4932/16/XXXX-0001
DOI: 10.1097/SLA.0000000000005199

CE: D.C.; ANNSURG-D-21-01390; Total nos of Pages: 9;
ANNSURG-D-21-01390

exploratory SPA questions using binary outcomes, Likert scales and free-text boxes. Scores allowed statistical comparison between sub-groups, populations norms and examination of the surgical performance anxiety inventory (SPAI) psychometric properties. Free-text questions allowed thematic analysis of key aspects of SPA. The study design was developed to promote surgeon engagement across specialties on a national level, whilst also facilitating a more in-depth understanding. The survey was anonymized. Priori power analysis indicated that 264 trainees and consultants were needed to detect a significant difference in SPA between the 2 groups, with $\alpha = 0{\cdot}05$ (2-sided) and a power of 90%.

The working definition of SPA was stated explicitly as: "A state of anxiety in response to perceived negative evaluation by others, concerning the performance of a surgical task."

The research was sponsored by Oxford University Hospitals NHS Foundation Trust, prospectively registered with the Health Research Authority and granted ethical approval from the University of Oxford Medical Sciences Inter-Divisional Research Ethics Committee. All participants confirmed they read an information sheet, before providing written consent to proceed.

Data Collection

Demographics

- Age
- Sex
- Surgical specialty
- Surgical experience

A summary of all measured used is provided in Table 1.[19–22,24]

Surgical Performance Anxiety (Appendix 1, http://links.lww.com/SLA/D420)

The SPAI was based on the Cox and Kennedy musical PA scale[9] with statements adapted to the setting of a surgical operation. Although other measures of PA are available within the sport and music literature, the chosen measure proved the most readily transferrable to the operating theatre setting and appreciable to surgeons with minimal modification, whereas still measuring both somatic and cognitive domains of PA.

Participants were also asked about when SPA was experienced (before, during or after a procedure), triggers, coping strategies, the impact (and severity thereof) of SPA on surgical performance and wider implications of SPA on surgical performance, surgeons' behavior and surgeons' wellbeing.

Perfectionism

Trait perfectionism was defined as exceedingly high standards, a propensity for overcritical evaluations and disproportional negative reactions to mistakes,[23] whereas surgical perfectionism refers to perfectionistic tendencies in an operation setting.

Wellbeing

The Short Warwick Edinburgh Mental Wellbeing Scale (SWEMWBS) was selected over the full version to reduce the survey burden.[21] The short version performs similarly to the full-length Warwick-Edinburgh Mental Wellbeing Scale[24] and has been validated in the general population.[24] It demonstrates good internal consistency in both United Kingdom (U.K.)[24] and European cohorts[25] and has been shown to have good convergence and discriminatory validity in U.K.[24] and European[25] populations. However, it may be less sensitive to sex differences.[24]

Survey Distribution

Recruitment methods were kept broad and included online (social media) distribution, personal communications, presentations, journal communications, and U.K. surgical societies.

Data collection ran from 11/09/19 to 25/03/20. Recruitment was stopped prematurely due to the COVID-19 pandemic. The study sponsor paused all non-COVID-19 pandemic research and the decision was made not to restart data collection thereafter as pre- and post/peri- pandemic results would not be comparable and target power had been achieved.

Inclusions/Exclusion Criteria

All surgeons ($\geq$1-year postgraduate surgical training) working in the U.K. were eligible for inclusion. Doctors post-medical school graduation but pre-formal surgical training were excluded.

Data Analysis

Responses were excluded from analysis if they did not confirm consent or indicated they were not eligible. Thereafter responses were excluded if no questions or demographics only were completed.

Missing Data

Responses for each measure were excluded if data were less than 85% complete. When less than 15% of individual answers per measure were missing, case mean substitution from the answers of that measure was used. This was performed before

reverse scoring, where applicable. Completeness of data was calculated for measures and demographics. Outliers were identified by exploratory data analysis. No data points were more than 3 standard deviations (SDs) from the mean and, therefore, none required exclusion.

Analysis

Statistical analysis was performed using SPSS (v26). Cronbach alpha was calculated for all measures. Descriptive analysis was performed for demographics and SPA exploratory questions. Percentages were rounded to the nearest whole number. Within this, analysis excluded nonresponders apart from when reporting the use of medication and psychological counselling, as the rate of nonresponders was disproportionately high for these questions and are, therefore, worthy of discussion. For comparison with published norms (where available) 1-sample *t* tests were calculated with mean values. Demographics were compared using independent sample *t* tests to assess for significant differences. Cohen *d* values were calculated as effect sizes for all *t* test analysis. Multiple linear regression procedures were used for to investigate the effect of independent background variables (sex, surgical experience, surgical perfectionism) on SPA. When comparing consultant and trainee surgeons, the consultant group included associate specialists and trainee group included staff grades and post CCT fellows. Receiver operator characteristic (ROC) analysis was conducted to test the discriminative power of the SPAI. AQ4

Thematic analysis was performed in-line with guidance from Braun and Clarke.[26] Theoretical thematic analysis was conducted at a semantic level on free text answers within SPA exploratory questions.

RESULTS

Survey Summary & Demographics

A total of 631 responses were collected. After exclusion, 523 (83%) were included in analysis. The completeness of included responses for demographics and specific measures (in the order they appeared) was: demographics 99%, SWEMWBS 100%, trait perfectionism 94%, trait anxiety 92%, SPA 89%, and surgical perfectionism 83%.

© 2021 Wolters Kluwer Health, Inc. All rights reserved.

CE: D.C.; ANNSURG-D-21-01390; Total nos of Pages: 9;
ANNSURG-D-21-01390

TABLE 1. Summary of Measures

Measure	Construct Measured	Measure Description	Measure Composition	Scoring	Cronbach α (Published Studies)	Cronbach α (Current Study)
Spielberger State-Trait Anxiety Inventory (STAI) Form-Y[19]	Trait Anxiety	Measures stable differences in an individual's baseline anxiety level	• 20-item self-report measure) • Frequency symptoms are experienced rated on a 4-point scale from 1 (almost never) to 5 (almost always)	Scored in line with STAI scoring key. Summative scores are produced after reverse scoring of items 1, 3, 6, 7, 10, 13, 14, 16 & 19.	The STAI has been extensively used throughout the anxiety literature with good reported reliability and validity) α = 0.90 (overall median in normative samples[19])	α = 0.61
Surgical Performance Anxiety Inventory (SPAI) (appendix 1, http://links.lww.com/SLA/D420)	Surgical Performance Anxiety	Measures differences in performance related anxiety within a surgical operating theatre	• 20-item self-report measure assessing the frequency participants experience cognitions (10-items) and somatizations (10-items) related to PA) • Frequency symptoms are experienced rated on a 5-point scale from 1 (never) to 5 (always)	Summative score produced after reverse scoring of items 13 & 15. Overall, somatic and cognitive scores produced	N/A	Overall: α = 0.92) Somatic: α = 0.85) Cognitive: α = 0.89
Stober Trait Perfectionism) Measure[20]	Trait Perfectionism	Explores concerns over mistakes, and doubts about actions (CMD)[22] in general) (From the Frost Multidimensional Perfectionism Scale (FMPS) by Stober[20])	• 13-item self-reported measure) • Frequency symptoms are experienced rated on a 5-point scale from 1 (strongly disagree) to 5 (strongly agree)	A mean score is calculated) Higher scores indicate higher perfectionistic concerns	α = 0.92[16]	α = 0.89
Surgical Perfectionism) (Appendix 1, http://links.lww.com/SLA/D420)	Surgical Perfectionism	Explores how participants generally feel during an operation (Adapted from the Stober et al, perfectionism measure in athletes[22])	• 10-item self-reported measure measuring striving for perfection (SP; 5-items) and negative reactions to imperfection (NRI; 5-items) during operations.) • Participants indicated how they generally felt during an operation on a 6-point scale from 1 (never) to 6 (always)	A mean score for each subscale and overall measure is calculated Higher scores indicate higher perfectionistic strivings and more negative reactions to imperfection	SP α = 0.92[16]) NRI α = 0.89[16]) (in nonsurgical cohort)	Overall: α = 0.92) SP: α = 0.93) NRI: α = 0.89
Short Warwick-Edinburgh Mental Wellbeing Scale (SWEMS)[21]	Wellbeing	Measures mental wellbeing in participants by providing a wellbeing score	• 7-item self-reported measure) • Participants indicate how the generally feel on a 5-point scale from 1 (none of the time) to 5 (all of the time)	Raw summative scores were calculated and converted to metric scores in line with the measure manual[24]	α = 0.84) (U.K. general population[24])	α = 0.87

Summary of psychometric measures.

© 2021 Wolters Kluwer Health, Inc. All rights reserved.

CE: D.C.; ANNSURG-D-21-01390; Total nos of Pages: 9;
ANNSURG-D-21-01390

Mean participant age was 41·2 (range 25–76; SD 10·19). Mean surgical experience in years was 15·3 (range 1–52). Consultants represented 52% versus 48% trainees. Overall, 62·7% of participants were male, 36·9% female and 0·4% preferred not to say.

Surgical Performance Anxiety

All participants (100%) thought SPA affected surgeons, even if they may not have experienced it themselves. A total of 65% of participants reported that SPA negatively impacted their surgical performance and 96% felt SPA impacted surgeons' wellbeing. A total of 58% reported currently experiencing SPA (''active-SPA group''), 29% reported that they had experienced SPA in the past (''past-SPA group'') and 13% reported having never experienced it. Most participants who experienced SPA did so before (98%), followed by during (96%) and least after (83%) surgery. A total of 70% of responders felt SPA could have a positive impact on surgical performance.

The SPAI demonstrated strong internal consistency (Table 1). The exclusion of any 1 individual item did not improve the level of internal consistency and the minimum corrected item-total correlation was $r = 0{\cdot}39$. There was good convergent validity between the SPAI and State-Trait Anxiety Inventory, $r = 0{\cdot}64$, $P < 0{\cdot}0001$.

ROC analysis demonstrated good accuracy (area under the curve = 0·88), with an optimum cut-off point of 40 producing a sensitivity of 0·81, a specificity of 0·78 and a positive predictive value of 0 86.

SPAI criterion validity was confirmed by comparing the active-SPA group to a group including the past-SPA group and those who had never experienced it. The active-SPAI group rated themselves significantly higher on the SPAI ($M = 49{\cdot}23$) than those who had only experienced PA in the past or had never experienced it ($M = 34{\cdot}07$); $t(465) = 16{\cdot}53$, $P < {\cdot}0001$, $d = 1{\cdot}59$, with a large effect size. Female surgeons reported significantly higher levels of SPA ($M = 46{\cdot}33$) than male surgeons ($M = 40{\cdot}77$), $t(463) = 4{\cdot}85$, $P < 0{\cdot}001$, $d = 0{\cdot}46$. Increased age ($r = -0{\cdot}37$, $P < 0{\cdot}001$) and greater experience ($r = -0{\cdot}37$, $P < 0{\cdot}001$) both demonstrated an identical significant association with lower levels of SPA. Despite lower SPA being significantly associated with greater experience, 45% of consultants reported currently experiencing SPA and 41% of consultants scored $\geq$40 on the SPAI.

Thematic Analysis

Triggers

At least 1 SPA trigger was identified by 57% of respondents in the active and past SPA groups. Thematic analysis demonstrated 3 clear themes: technical, nontechnical, and environmental. Nontechnical triggers were more common than technical or environmental triggers. By far the most common trigger sub-theme was ''colleagues within the parent speciality'' (Fig. 1).

Reported triggers for SPA

Sub-themes	Mentions	Most	Explanation & examples (where appropriate)
Colleagues within speciality	151		This is divided into worry about negative evaluation (120), lack of support (27), anxiety regarding training (4). Examples: *"I lost my confidence coming back to work from maternity leave and colleagues were critical and unsupportive"; "senior who simply goes around putting people down for a sport and gloats about it overtly"; "Very authoritarian trainers, one who was sexist and a bully"; "When doing a difficult but critically important procedure, I worry that my colleagues could do it better"; "Decision making during an emergency out of hours and that being questioned during the light of day"*
High complex/ high risk cases	66		Eg: rare, complex or revision cases
Lack of experience	30		—
A specific procedure	28		—
Time	22		This can be divided into intra-operative time pressure (13), pre-operative time pressure (3) and operating out-of-hours (6)
General theatre environment	16		This include excess noise or distractions within theatre.
Colleagues outside specialty	14		Example: *"Scrub nurse asking consultant if my work is good enough, consultant gives quick glance and says no not at all and calls someone else in to do it or reaches over and yanks my sutures out with instrument"*; "*Being handed a part of an operation to do on the spot (especially an unfamiliar one / unfamiliar equipment) which leaves little time for mental pre-preparation*"
Team ability	14		This refers to the ability of the wide surgical team (e.g. scrub team or surgical assistants). *Example: "If I know the theatre team are new and don't know how I like things done then it upsets my routines and this causes anxiety"*
Managerial issues	13		This includes being contacted for managerial issues pre- or intra-op and not having enough beds, for example. Example: *"managing multiple theatres or being asked lots of questions about patients when I'm operating"*
Personal	12		Example: *"feeling low in my personal life", "family expectations"*
Acute complications	7		—
General audience	5		—
Miscellaneous	3		—
Previous adverse events/ mistakes/ complications	3		Example: *"…[operations] that I have previous had adverse outcomes with"*
Physical	3		—
		Least	

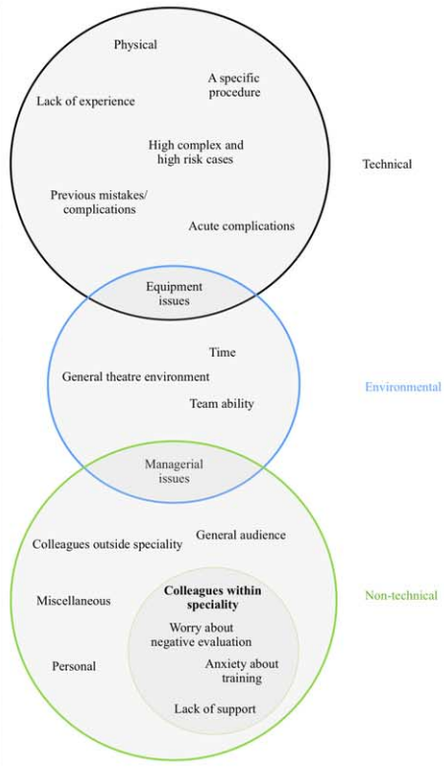


FIGURE 1. Demonstrates SPA triggers reported by participants. The table indicates the sub-themes identified, the number of times reported and, where appropriate, a further breakdown of sub-theme with examples/quotes. The Venn diagram illustrates the major themes (technical, nontechnical, and environmental), the categorization of sub-themes within these and the relationship between major themes. SPA indicates surgical performance anxiety.

© 2021 Wolters Kluwer Health, Inc. All rights reserved.

CE: D.C.; ANNSURG-D-21-01390; Total nos of Pages: 9;
ANNSURG-D-21-01390

Reported techniques for overcoming SPA

Sub-themes	Times recorded	Most	Explanation & examples (for the 5 most common themes only)
Planning & preparation	169		Examples: "*meticulous planning*"; "*good preparation/ revision of technique*"; "*reading and consulting with colleagues*"; "*visualise the procedure several times before…*"
Talking	153		This includes talking to colleagues (in a clinical and mentorship capacity peri- and intra-operatively), talking to non-clinical friends, talking to yourself (verbal and non-verbally) and talking in general (without specific direction). Examples: "*talking through what I'm doing*"; "*talking to colleagues*"
Self-care	88		This includes activities such as going to the loo, hydration and exercise. Examples: "*Ensuring I have eaten/ drank/ used the toilet*", "*exercise and baking*"; "*Distraction - usually once at home and away from the work environment the anxiety dissipates as I get a sense of perspective*"
Relaxation techniques	88		Relaxation techniques include techniques to promote a sense of physical calm, such as deep or controlled breathing.
Mental break	51		This refers to taking a 'step back', 'taking a moment', slowing down, having a break and stopping during the procedure
Formal reflection & debrief	33		———
Shutting out distractions	32		———
Music	26		———
Positive self-statements	22		———
Mindfulness	17		———
Patient focus	10		———
Routines & rituals	10		———
Prayer	9		———
Meditation	8		———
Avoidance	3		———
Medication	2		———
Acceptance	1		———
		Least	

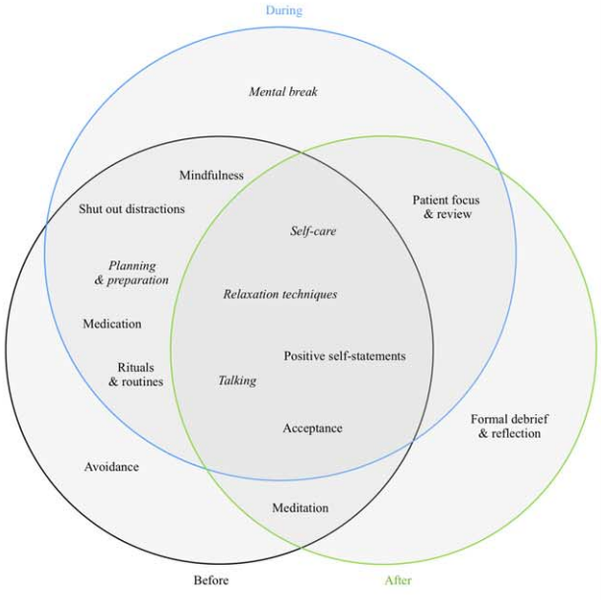


FIGURE 2. Demonstrates reported techniques for overcoming SPA by participants. The table indicates sub-themes identified, the number of times reported and examples/quotes for the top 5 sub-themes. The Venn diagram illustrates these techniques by time of use (before, during, or after operating), the categorization of sub-themes within these and areas of overlap of when techniques can be used. Key themes are highlighted in italics. SPA indicates surgical performance anxiety.

Coping Mechanisms

Of those experiencing SPA, 45% reported a technique for overcoming it. Overall, 50% reported their techniques were effective "almost always." Three percent reported using medication for SPA, although 47% did not respond to the question (65% of the active group did not respond vs 10% of the past group). Nine percent received psychological counselling, 44% have not received any and 47% did not respond. Nine percent of those experiencing SPA reported sharing it openly, 27% confided in someone and 47% did not respond.

Thematic analysis of techniques was divided by timing (before, during, and after surgery). Ubiquitous key themes were "self-care," "relaxation techniques" and "talking." "Mental break" was a prominent theme, although only applicable intraoperatively, as was "planning & preparation" although this was not applicable post-op (Fig. 2). Thematic analysis of proposed interventions by participants for SPA demonstrated 3 overlapping themes using personal, local and institutional approaches (Fig. 3).

Positive Impact

Thematic analysis to understand how or why SPA may have a positive impact, demonstrated 7 themes (in order of maximum frequency): "shutting out distractions," "improved preparation," "improved situational awareness," "improved reflection," "preventing overconfidence," "improved motivation/determination," "improved performance."

Perfectionism

The internal consistency of the Surgical Perfectionism scale was high (Table 1). The exclusion of any item did not increase the level of internal consistency with a minimum corrected item-total correlation was 0·57. There was good convergent validity between the Surgical Perfectionism scale and the frost multidimensional perfectionism scale; $r = 0{\cdot}61$, $P < 0{\cdot}0001$. Surgical perfectionism was not significantly associated with age or years of experience and there were no significant sex differences ($P > 0{\cdot}05$). The active-SPA group reported significantly higher levels of surgical perfectionism ($M = 40{\cdot}66$) compared to those not currently experiencing PA ($M = 35{\cdot}18$); $t(432) = 5{\cdot}61$, $P < 0{\cdot}001$, $d = 0{\cdot}55$. There was a significant association between SPA and surgical perfectionism, $r = 0{\cdot}39$, $P < 0{\cdot}001$.

Predictors of SPA

Hierarchical multiple regression analysis indicated self-reported SPA was best predicted by sex, years of surgical experience

© 2021 Wolters Kluwer Health, Inc. All rights reserved.

CE: D.C.; ANNSURG-D-21-01390; Total nos of Pages: 9;
ANNSURG-D-21-01390

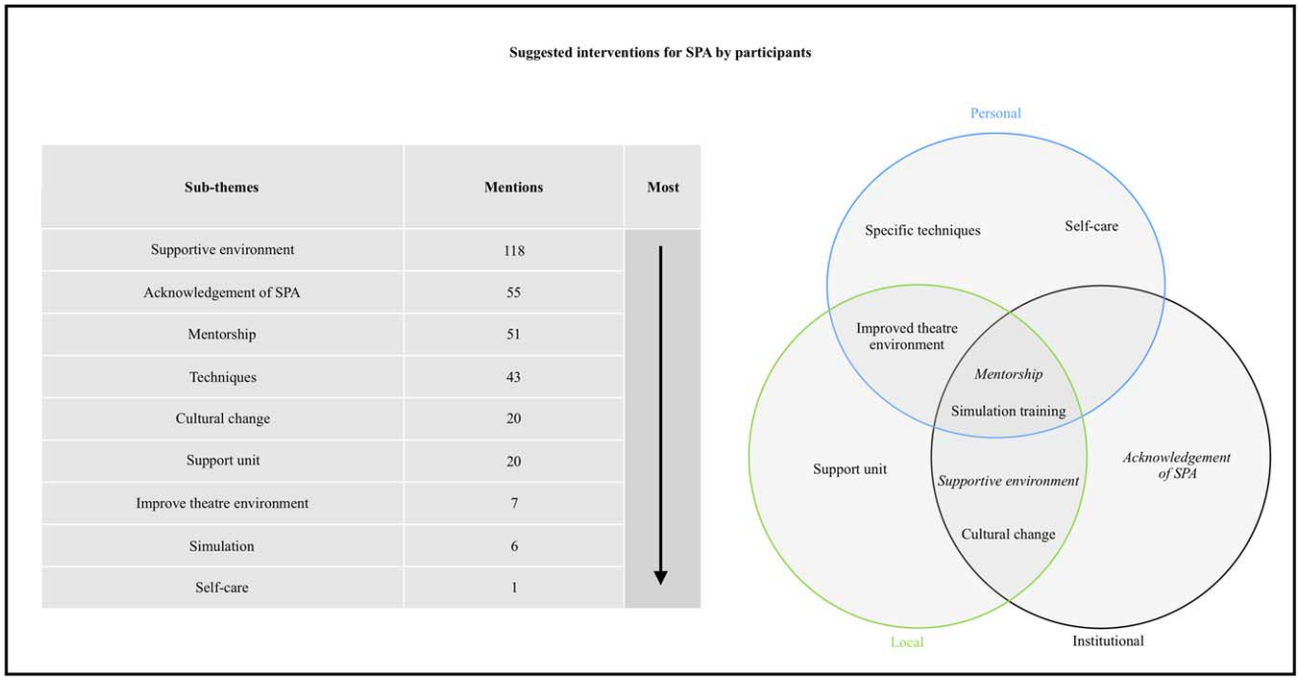


FIGURE 3. Demonstrates suggested interventions for SPA by participants. The table indicates the sub-themes identified and the number of times reported. The Venn diagram illustrates the major themes (at personal, local, and institutional levels), the categorization of sub-themes within these and the relationship between major themes. Key themes are highlighted in italics. SPA indicates surgical performance anxiety.

and levels of surgical perfectionism. These were all significantly predictive of SPA (Table 2).

Wellbeing

Male surgeons reported significantly better mental wellbeing ($M = 22{\cdot}99$) than female surgeons ($M = 21{\cdot}91$); $t(519) = 3{\cdot}017$, $P = {\cdot}003$, $d = 0{\cdot}27$. Both male ($M = 21{\cdot}80$ vs $M = 24{\cdot}20$); $t(282) = 5{\cdot}32$, $P < 0{\cdot}0001$, $d = 0{\cdot}63$, and female ($M = 21{\cdot}15$ vs $M = 23{\cdot}76$); $t(177) = {\cdot}35$, $P < {\cdot}001$, $d = 0{\cdot}67$, surgeons currently experiencing SPA reported significantly worse mental wellbeing than those who were not currently experiencing SPA. Both older age ($r = 0{\cdot}24$, $P < 0{\cdot}0001$) and greater years of surgical experience ($r = 0{\cdot}26$, $P < 0{\cdot}0001$) were significantly associated with better mental wellbeing.

Compared with population norms for England, both male and female surgeons reported significantly lower mental wellbeing (male: $M = 22{\cdot}99$ vs $M = 23{\cdot}67$; $t(12274) = 3{\cdot}099$, $P = 0{\cdot}0019$, $d = 0.17$ and female: $M = 21.91$ vs $M = 23{\cdot}59$; $t(15412) = 5{\cdot}81$, $P = 0{\cdot}0001$, $d = 0{\cdot}42$). Normative data for doctors is not available for the SWEMWBS.

TABLE 2. Contributors to Surgical Performance Anxiety

	B	SE B	ß
Step 1			
Constant	46·4	0·96	
Sex	−5·93	1·21	−0·23*
Step 2			
Constant	33·28	2·22	
Sex	−3·28	1·08	−1·29*
Years of surgical experience	−0·38	0·047	−·33*
Surgical perfectionism	0·45	0·05	0·38*

$R^2 = 0{\cdot}054$ for Step 1; $R^2 = 0{\cdot}24$ for Step 2 (Ps $< 0{\cdot}001$). * $P < 0{\cdot}001$.
Hierarchical multiple regression demonstrating female sex, fewer years of surgical experience and greater surgical perfectionism predict higher levels of SPA.

DISCUSSION

There is a growing awareness of the need to address cognitive and nontechnical aspects of performance in healthcare, particularly surgery[1] to optimize patient outcomes. In parallel, there is a greater understanding of the psychological challenges faced by healthcare professionals and their impact on wellbeing. Nonetheless, anxiety among surgeons has received little attention. Indeed, PA in healthcare is poorly studied[3,13] even though it has been well described in music[7–9] and sport.[6] With over 7 million surgical procedures performed annually in the U.K.,[27] surgeons must be supported to optimize their surgical performance and psychological wellbeing should be an important aspect of this. For this study, the definition of SPA was based on the DSM 5 definition of PA.[28] Our study found that SPA is a common and major challenge for surgeons in the U.K. with a prevalence of 87% in our cohort. Moreover, all respondents who have not experienced SPA believed it affected surgeons of all grades with 96% believing it negatively impacted wellbeing. Qualitative data provide evidence that within the surgical community there remains a reticence to share SPA openly, and a need to acknowledge it at personal, local and institutional levels to facilitate a cultural change within surgery. One respondent makes this point succinctly: ''I wish we talked about it more and shared our insecurities. Most of my colleagues pretend they are living gods'' – Consultant general surgeon.

Impact of SPA on Performance

The relationship between the cognitive aspects of performance and technical performance is complex.[15] A total of 65% of respondents who experienced SPA felt it compromised their performance.

© 2021 Wolters Kluwer Health, Inc. All rights reserved.

CE: D.C.; ANNSURG-D-21-01390; Total nos of Pages: 9;
ANNSURG-D-21-01390

Yet, 70% of respondents felt SPA could have a positive effect. This may be explained by the traditional bell-curve relationship between arousal and performance,[29] which describes a dose dependent relationship between performance and arousal until a ''tipping point'' after which performance declines. A heightened sense of awareness secondary to anxiety may be beneficial but at high doses, anxiety can negatively affect attentional control[5] and cause somatic symptoms. Based on ROC analysis in our study, an SPAI score of 40 may represent the point at which SPA is experienced. The challenge would be to reap the benefits of low-level stimulation without incurring possible adverse effects. However, recent models have suggested this is an over-simplification as it is unclear how a heightened sense or awareness secondary to raised anxiety levels may interplay in cases with high stress or high trait worry, for example, as proposed by the Hardy and Fazey catastrophe model.[15] Although it was beyond the scope of this study to establish a quantitative relationship between SPA and surgical performance or outcomes through a reductionist approach, our qualitative data were able to identify those at risk of experiencing SPA.

SPA, Wellbeing & Opportunities for intervention

The SWEMWBS was used to provide a quantitative wellbeing score and help understand how SPA relates to wellbeing. To our knowledge, this is the first study to use this measure in surgeons. However, although it demonstrated excellent psychometric properties, interpreting the results is challenging. All results fell within the ''medium'' wellbeing category[24] (where low and high scores are at least 1 SD above and below the mean respectively) and the clinical relevance of different scores is unknown. We found a significant correlation between SPA and lower wellbeing. Although the direction of causality is unknown, it is consistent with the finding that 96% of responders felt SPA had an adverse effect on wellbeing.

Thematic analysis highlights SPA triggers are multifactorial, with 3 main themes: technical, nontechnical, and environmental. The most common sub-themes were ''colleagues within specialty,'' ''high complex/high risk cases'' and ''lack of experience'' (Fig. 1). Although ''colleagues within specialty'' were reported more often by trainees than consultants, the remaining trigger sub-themes were evenly split. Similarly, in sport, a negative rapport between coach and athlete contributes to anxiety[30] with a high negative rapport increasing perceived negative consequences of an unsuccessful performance. More in-depth qualitative research is required to fully elucidate these triggers, and specifically the role of colleagues as surgeons progress through training and consultant years. Perhaps surprisingly, SPA was rarely reported as a consequence of a previous bad experience. Furthermore, the most frequently reported intervention suggested by participants was a supportive environment and acknowledgment of SPA, indicating that existing working/ training relationships may be improved to reduce perceived evaluation and related anxiety.

Importantly, surgeon wellbeing was significantly worse than population norms and female surgeons experienced significantly worse wellbeing than male surgeons, in contrast to no significant sex difference on a national level.[24] Despite interpretive challenges, this raises important questions regarding surgery within the U.K. Furthermore, hierarchical multiple regression analysis suggests female sex may also contribute to SPA, highlighting the need for future research to explore the role cultural factors within the surgical profession may play in these sex differences. We suggest that, with ongoing use, the SWEMWBS measure may prove useful for assessing trends in a medical settings and comparison with national and international cohorts (particularly in light of COVID-19, where these current data provide a unique pre-pandemic snapshot).

As highlighted above, understanding the psychological traits for surgeons may identify those at risk of experiencing SPA, or experiencing adverse effects of SPA (related to performance, wellbeing or both). In turn, this would allow effective targeting of interventions and support. A psychological trait pertinent to SPA[8] (and commonly associated with surgeons) is perfectionism. We demonstrate a significant correlation between perfectionism and SPA, indicating that high levels of surgical perfectionism in surgeons may help identify those at risk of SPA. Although perfectionism may be a beneficial trait in surgery, our findings from hierarchical multiple regression analysis also indicate that perfectionism (and sex and experience) may drive SPA and help predict those experiencing SPA (Table 2).

Limitations

The study cohort is broadly representative of U.K. surgeons and, therefore generalizable, although we acknowledge the limitations of any cross-sectional study[31] (Table 3). The higher representation from neurosurgery and plastic surgery and a lower representation from trauma & orthopedics may reflect disruption of distribution channels used as a result of early termination of recruitment due to the COVID-19 pandemic. Although SPAI has not been validated in surgeons, the primary outcome of this study was to determine if SPA exists and warrants further investigation. Importantly, we found the psychometric properties of the SPAI to be acceptable, supporting its use in this (and future) studies. Future studies should focus on establishing the impact of different levels of SPA on performance and wellbeing and how interventions can mitigate the negative impacts of anxiety. As this was an exploratory study of a new field, we did not aim to provide an in-depth qualitative analysis of SPA, which limited the level of detail that could be extracted from the thematic analysis. Hence our reporting was deliberately cautious to avoid overinterpretation. We offer overall thematic analysis regarding triggers, techniques and interventions, but further qualitative research is needed. Selection bias and nonresponse bias are limitations, although the direction and quantification of these are unknown. Recall bias is a risk both in general but

TABLE 3. Demographics

	NHS England Data [30] – % (n)	Survey Data – % (n)
Grade		
Consultant	47·6 (9745)	52·2 (328)
Trainee	52·4 (10,700)	47·8 (193)
Sex		
Overall: male|female	73|27	62·4|36·7
Consultants: male|female	75|25	72·8|27·2
Trainees: male|female	72·8|27·2	63|37
Speciality		
Cardio-thoracic surgery	4	2·3
General surgery	28	24
Neurosurgery	4	12·2
Oral and maxillofacial surgery	7	1·9
Otolaryngology	9	7·8
Pediatric surgery	2	2·3
Plastic surgery	6	18
Trauma and orthopedic surgery	29	17·2
Urology	9	5·6
Vascular surgery	2	3·3
Ophthalmology*	N/A	1·4
Speciality unspecified/ undecided*	N/A	3·9

*Not within NHS digital data for U.K. surgeons.
Table comparing survey demographics to the U.K. surgeon population.

© 2021 Wolters Kluwer Health, Inc. All rights reserved.

CE: D.C.; ANNSURG-D-21-01390; Total nos of Pages: 9;
ANNSURG-D-21-01390

particularly when comparing active- and past-SPA groups. This may result in lower reporting of past-SPA in older participants. Caution has, therefore, been used comparing subgroups. Interestingly, although completeness of data is generally high across the measures used (83%–100%; despite some survey fatigue) specific questions regarding use of medication and psychological counselling had very poor response rates. Overall, 3% reported using medication for SPA, but 47% did not respond to this question. 65% of the active group did not respond versus 10% of the past group, highlighting those currently experiencing SPA may not feel comfortable disclosing this information. Whilst we attempted to reduce social desirability bias by using an anonymized survey, it remains a possibility, as does demand characteristics bias. Again, the direction of any effect cannot be predicted. Acquiescence bias was reduced by avoiding binary positive and negative responses but remains a risk.

Summary & Future Direction

This study demonstrates the high prevalence and challenge of SPA in surgeons of all specialties and at all levels of experience. It is perceived by surgeons to adversely affects their psychological well-being and surgical performance. A more open culture of sharing and discussing this topic has been identified to be beneficial. It must be remembered that surgical performance involves a complex interplay between psychological traits, psychomotor skills, patient and procedure factors, surgical team factors and external pressures. Furthermore, of particular interest, we have identified the role of sex in SPA and wellbeing which warrants further investigation. Further qualitative research, including using semi-structured interviews, is needed to understand triggers, techniques and interventions in greater depth in order to offer tangible and acceptable solutions to surgeons. Support systems are recommended to identify and support surgeons experiencing SPA and future research will also benefit from evaluating the impact of SPA on surgical performance and identifying those interventions that are most effective for, and acceptable to, this population.

ACKNOWLEDGMENTS

The authors thank all those that, to our knowledge, helped distribute our survey across the U.K. Specific thanks go to the Royal College of Surgeons of England, The Royal College of Surgeons of Edinburgh Faculty of Surgical Trainers, ENT UK, Association of Breast Surgery, The Society of British Neurological Surgeons and Health Education England London and Severn deanery for their support.

The authors also thank to acknowledge Dr Denis O'Leary, consultant psychiatrist, who sadly passed away during the course of this study. He was actively involved with the design and set up of the study.

AQ5

REFERENCES

1. Wetzel CM, Kneebone RL, Woloshynowych M, et al. The effects of stress on surgical performance. *Am J Surg*. 2006;191:5–10.
2. Lebares CC, Guvva EV, Olaru M, et al. Efficacy of mindfulness-based cognitive training in surgery: additional analysis of the mindful surgeon pilot randomized clinical trial. *JAMA Netw Open*. 2019;2:e194108.
3. Hotton M, Miller R, Chan J. Performance anxiety among surgeons. *Bull R Coll Surg Engl*. 2019;101:20–26.
4. Lang PJ, Davis M, Ohman A. Fear and anxiety: animal models and human cognitive psychophysiology. *J Affect Disord*. 2000;61:137–159.
5. Allsop J, Gray R. Flying under pressure: effects of anxiety on attention and gaze behavior in aviation. *J Appl Res Mem Cognit*. 2014;3:63–71.
6. Cheng WN, Hardy L, Woodman T. Predictive validity of a three-dimensional model of performance anxiety in the context of tae-kwon-do. *J Sport Exerc Psychol*. 2011;33:40–53.
7. Kenny D. *A Systematic Review of Treatments for Music Performance Anxiety. Vol 18*. Anxiety, Street & Coping; 2005.
8. Kenny DT, Davis P, Oates J. Music performance anxiety and occupational stress amongst opera chorus artists and their relationship with state and trait anxiety and perfectionism. *J Anxiety Disord*. 2004;18:757–777.
9. Cox W, Kennedy J. Performance anxiety social phobia, and setting effects in instrumental music students. *J Anxiety Disord*. 1993;7:49–60.
10. Woodman T, Hardy L. The relative impact of cognitive anxiety and self-confidence upon sport performance: a meta-analysis. *J Sports Sci*. 2003;21:443–457.
11. Rui M, Lee JE, Vauthey JN, et al. Enhancing surgical performance by adopting expert musicians' practice and performance strategies. *Surgery*. 2018;163:894–900.
12. Church HR, Rumbold JL, Sandars J. Applying sport psychology to improve clinical performance. *Med Teach*. 2017;39:1205–1213.
13. Dupley L, Hossain S, Ghosh S. Performance anxiety amongst trauma and orthopaedic surgical trainees. *Surgeon*. 2020;18:e33–e38.
14. Arora S, Sevdalis N, Nestel D, et al. The impact of stress on surgical performance: a systematic review of the literature. *Surgery*. 2010;147:318–330.
15. Hardy JP, Fazey JA. The inverted-U hypothesis - a catastrophe for sport psychology and a statement of a new hypothesis. Presented at: Annual Conference of the North American Society for the Psychology of Sport and Physical Activity; 1987; Vancouver.
16. Araújo LS, Wasley D, Perkins R, et al. Fit to perform: an investigation of higher education music students' perceptions, attitudes, and behaviors toward health. *Front Psychol*. 2017;8:1558.
17. Montgomery A, Panagopoulou E, Esmail A, et al. Burnout in healthcare: the case for organisational change. *BMJ*. 2019;366:l4774.
18. Greenberg N, Rafferty L. Post-traumatic stress disorder in the aftermath of COVID-19 pandemic. *World Psychiatry*. 2021;20:53–54.
19. Spielberger CD, Gorsuch RL, Lushene R, et al. *Manual for the State-Trait Anxiety Inventory*. Palo Alto: CA: Consulting Psychologists Press; 1983.
20. Stöber J. The frost multidimensional perfectionism scale revisited: more perfect with four (instead of six) dimensions. *Pers Individ Differ*. 1998;24:481–491.
21. Short Warwick Edinburgh Mental Wellbeing Scale (SWEMWBS) © NHS Health Scotland UoWaUoE, 2008, all rights reserved. Accessed October 03, 2020
22. Stöber J, Otto K, Pescheck E, et al. Perfectionism and competitive anxiety in athletes: differentiating striving for perfection and negative reactions to imperfection. *Pers Individ Dif*. 2007;42:959–969.
23. Frost RO, Lahart MP, Rosenblate R C. The dimensions of perfectionism. *Cognit Ther Res*. 1990;14:449–468.
24. Ng Fat L, Scholes S, Boniface S, et al. Evaluating and establishing national norms for mental wellbeing using the short Warwick-Edinburgh Mental Well-being Scale (SWEMWBS): findings from the Health Survey for England. *Qual Life Res*. 2017;26:1129–1144.
25. Koushede V, Lasgaard M, Hinrichsen C, et al. Measuring mental well-being in Denmark: validation of the original and short version of the Warwick-Edinburgh mental well-being scale (WEMWBS and SWEMWBS) and cross-cultural comparison across four European settings. *Psychiatry Res*. 2019;271:502–509.
26. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol*. 2006;3:77–101.
27. Abbott TEF, Fowler AJ, Dobbs TD, et al. Frequency of surgical treatment and related hospital procedures in the UK: a national ecological study using hospital episode statistics. *Br J Anaesth*. 2017;119:249–257.
28. American Psychiatric Association. (2013). Diagnostic and Statistical Manual of Mental Disorders. (5th ed.).
29. Yerkes RM, Dodson JD. The relation of strength of stimulus to rapidity of habit-formation. *J Comp Neurol Psychol*. 1908;459–482.
30. Baker J, Côté J, Hawes R. The relationship between coaching behaviours and sport anxiety in athletes. *J Sci Med Sport*. 2000;3:110–119.
31. [Dataset] Hospital and Community Health Services (HCHS) Data From NHS Digital: Doctors in the Surgical Specialties by Grade and Gender. 2020.

AQ6 AQ7 AQ8 AQ9 AQ10

© 2021 Wolters Kluwer Health, Inc. All rights reserved.

ANNSURG
Manuscript No. ANNSURG-D-21-01390

Annals of Surgery

Dear Author,

During the preparation of your manuscript for typesetting, some queries have arisen. These are listed below. Please check your typeset proof carefully and mark any corrections in the margin as neatly as possible or compile them as a separate list. This form should then be returned with your marked proof/list of corrections to the Production Editor.

QUERIES: to be answered by AUTHOR

QUERY NO.	QUERY DETAILS	RESPONSE
<AQ1>	Please confirm whether surnames/family names (red) have been identified correctly in the author byline.	
<AQ2>	Affiliations have been set as per style. Please check for accuracy of information.	
<AQ3>	Please check the ‘‘Disclosure’’ section for appropriateness.	
<AQ4>	Please provide the expansionS of ‘‘CCT’’ and ‘‘DSM’’.	
<AQ5>	Please validate the Acknowledgments secton.	
<AQ6>	Please validate journal title in references 3, 5, 20, 23, 26, and 29.	
<AQ7>	Please provide publisher location in reference 7.	
<AQ8>	Please provide complete bibliographic details in references 15, 21, 28, and 31.	
<AQ9>	Please validate volume and page range in reference 17.	
<AQ10>	Please provide volume number in reference 29.	
<AQ11>	If you have color in your proof, please indicate whether you approve the color charge by returning the color agreement with your corrections. The color agreement can be found at http://links.lww.com/SLA/B223. The price for the first color figure is $750. The charge for each additional color figure is $150. If you prefer black and white figures, please indicate so on your proof corrections.	