Exploring variation in surgical practice: does the surgeon's personality influence anastomotic decision-making?

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ABSTRACT

Background: Decision-making under uncertainty may be influenced by the individual's personality. The primary aim was to explore associations between surgeon personality traits and colorectal anastomotic decision-making.

Methods: Colorectal surgeons worldwide participated in a two-part online survey. Part 1 evaluated surgeon characteristics using the Big Five Inventory to measure personality (five domains: agreeableness; conscientiousness; extraversion; emotional stability; openness) in response to scenarios presented in Part 2 involving anastomotic decisions (i.e., rejoining the bowel with/without temporary stomas, or permanent diversion with end colostomy). Anastomotic decisions were compared using repeated measure ANOVAs. Mean scores of traits domains were compared with normative data using 2-tailed t-tests.

Results: 186 surgeons participated, with 127 surgeons completing both parts of the survey (68.3%). Most surgeons were male (n = 131, 70.4%) and Europe-based (n = 144, 77.4%). 41.4% began independent practice within the last five years (n = 77).

Surgeon personality differed from the general population, with significantly higher levels of emotional stability (3.25 vs 2.97 respectively), lower levels of agreeableness (3.03 vs 3.74), extraversion (2.81 vs 3.38) and openness (3.19 vs 3.67) and similar levels of conscientiousness (3.42 vs 3.40 (all $p < 0.001$)). Female surgeons had significantly lower levels of openness ($p < 0.001$) than males (3.06 vs 3.25). Personality was associated with anastomotic decision-making in specific scenarios.

Conclusions: Colorectal surgeons have different personality traits from the general population. Certain traits seem to be associated with anastomotic decision-making but only in specific scenarios. Further exploration of the association of personality, risk-taking and decision-making in surgery is necessary.

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ORIGINAL ARTICLE

Introduction

Personality is defined as "*the dynamic and organized set of characteristics possessed by a person that uniquely influences their cognitions, motivations and behaviours in various situations*" [1]. Personality may be objectively measured using validated self-reported measures [2]. Whilst personality is largely stable throughout the life span, it is possible to modify one's personality, following exposure to experience and/or through changes in beliefs and values [3, 4]. The relationship between personality and decision-making is well-established in non-medical vocations involving risk and uncertainty; and is strongly predictive of work behaviours across cultures [5]. Across multiple industries, personality has been found to influence decision-making, for example, in astronauts [6], military personnel [7, 8] and business executives [9]. Within the medical profession, personality testing has largely focused on selection into and attrition rates from undergraduate or postgraduate medical programmes as well as predicting examination outcomes [10 - 12]. However, there is limited work exploring how the physician or surgeon's personality may influence clinical decision-making under uncertainty when there is no clear gold standard [13 - 15].

Anastomotic decision-making in rectal cancer is complex and is an important example of how decision-making can impact patient care. There are three choices the surgeon and the patient must consider: to form a primary anastomosis alone, to form a primary anastomosis and temporarily defunction with a loop ileostomy (including the later decision to close the stoma), or not to anastomose at all and form a permanent end colostomy. Each decision has specific implications for both clinicians and patients in the short and longer term, which may impact quality of life, bowel function and surgery-specific complications [16-21]. Established patient factors in anastomotic decision-making such as significant comorbidity and frailty [22-24] do not wholly account for the substantial variation in surgical practice reported from national databases such as the National Bowel Cancer Audit (NBOCA) [25]. This variation leads us to consider the role played by the individual surgeon's personality. Previous work has suggested that surgeon personality [14], surgeons with a self-belief of possessing lower anastomotic leak rates and older surgeons, are more likely to form primary anastomosis alone, the higher-risk option, and

form fewer stomas [26, 27]. Further exploration in a larger sample across cultures is warranted to determine how surgeon personality influences the anastomotic decision and explore the surgeon's risk perception of anastomotic leakage.

The primary aim of this work was to determine if a relationship existed between surgeon personality and rectal anastomotic decision-making.

Identification of potentially 'beneficial' personality traits for patient care and post-operative outcomes was a secondary aim. The hypothesis was that surgeon personality may influence anastomotic decision-making, particularly those traits which may influence the individual surgeon's risk perception of anastomotic leakage.

Methods

This was a quantitative study using a cross-sectional design and a survey for data collection. Ethical approval was obtained from the University of Aberdeen College Ethics Review Board (CERB/2020/4/1984).

Participants

Surgeons from any country who met the following criteria were invited to participate: fully certified colorectal surgeons who independently perform more than 10 elective colorectal cancer operations per year and contribute to multi-disciplinary team (MDT) discussions (as per Association of Coloproctology of Great Britain and Ireland (ACPGBI) and National Institute for Health and Care Excellence (NICE) guidelines at time of ethical approval) [28, 29]. The exclusion criteria were: trainees/residents who had not yet completed their training, non-colorectal specialty general surgeons, or surgeons who did not meet the above definition of a colorectal cancer surgeon. Informed consent was obtained prior to survey commencement. Data was stored securely in accordance with the General Data Protection Regulation (EU-2016/789) and the UK Data Protection Act.

Recruitment and Dissemination

Recruitment was via social media (including Twitter via @plato_project), and invitational emails from professional bodies such as ACPGBI.

Data Collection

The survey was available in electronic format via Snap11 Professional and reported using the CHERRIES Checklist [30] (Appendix 1). Following a pilot study on four general surgery trainees to check for readability and repetition, the survey was divided into two parts (defined below) to reduce the time taken for each part (facilitating participation) and allowed participants undertaking Part 2 to complete the scenarios 'fresh' to mitigate the influence of social desirability response bias. Part 1 was open for a period of 12 weeks (14/8/20 - 5/11/20), subsequently closed to new participants, then Part 2 opened for 12 weeks (6/11/20 – 29/1/21). Only participants who completed Part 1 could participate in Part 2. Reminders were sent at regular intervals via social media and email invites from those registered for participation. Participation was incentivised by emailing individual results from the personality survey to those who had completed both parts. As participants submitted identifying information, duplicate entries were identified and removed. Survey participants could only scroll forwards and back, without a 'review' page prior to survey completion.

<u>Part 1</u>

Part 1 contained data items on: demographics (age range, gender, years of experience, country of practice) and the 44-item validated personality tool based upon the Five Factor Model of personality – the Big Five Inventory (BFI) (Appendix 2) [31, 32]. These demographics were of specific interest, given evidence from the general population that personality traits change with age [33, 34] and women tend to have higher levels of agreeableness and lower levels of emotional stability than men, findings which persist across cultures [35, 36]. In surgeon populations, increasing experience has been associated with increased risk-taking [26, 27].

The BFI has a large evidence base and high level of validity [32], encompassing personality into five broad domains: 1) openness to experience (degree of originality, creativity), 2) conscientiousness (degree of diligence, planful, rule-following), 3) extraversion (sociability, assertiveness), 4) agreeableness (degree of ability to get on well with others, conflict avoidance, modesty) and 5) emotional stability (even-temperedness versus neuroticism) [2,

37]. Each domain is considered a spectrum, with low, average, or high levels of each trait expressed by an individual. The Big Five Inventory scale scores each domain between 1 (low levels of trait) to 5 (high levels of trait). Some items require reverse-scoring. The final domain score is calculated from the mean of standard and reversed scored items. BFI tests which have six or less missing answers are still valid, provided they are from a spread of domains [32].

Part 2

Part 2 contained hypothetical clinical scenarios involving anastomotic decision making (Appendices 3 and 4). The scenarios were split into two themes: 1) Surgeon Factors, where surgeons ranked each scenario between 1 and 10 (where 1 was extremely unlikely to influence decision-making and 10 - extremely likely (Appendix 3)) and 2) Patient Factors – 10 scenarios with 'drop-down' options differing for each scenario based on relevance (Appendix 4). All scenarios were ambiguous to explore equipoise. Each hypothetical patient scenario was written based upon the personal experiences of steering group members, which included patient and public involvement (PPI) representation, and stratified by seven colorectal surgeons into high, medium, or low risk options. Steering group consensus of risk was taken as 70% (i.e., a minimum of five surgeon steering group members in agreement), in accordance with previous work [38]. For a limited number of scenario options, the risk-stratification category with the greatest frequency of steering group votes was used as the consensus option, as the small number of steering group members meant it was difficult to achieve consensus in all scenarios. This may reflect the hypothesised variation in practice amongst experts.

All options for anastomotic decisions were clinically acceptable options to explore equipoise within rectal cancer decision-making. Surgeons who contributed to writing the scenarios were excluded from the final analysis. Examples of scenarios relating to surgeon factors included decision-making following: recent personal or witnessed critique after a significant post-operative complication, a recent 'good run' of no anastomotic leak and working with unfamiliar colleagues (Appendix 3). Examples of scenarios relating to patient factors included: strong patient preferences regarding stomas, impending obstruction, or advanced

disease at time of presentation, and unexpected intra-operative events such as pelvic bleeding or ureteric injury (Appendices 3 & 4).

Statistical Analysis

All effect size estimates for power calculations were derived from a previous pilot study [14]. The ~~average~~ mean correlation between personality and decision-making is 0.37, therefore power calculation determined that a minimum of 52 participants was necessary to achieve a power of 0.80, with α (2-tailed) of 0.05. Spearman's rho and comparison across decision-making scenarios were used for repeated measure ANOVAs. One-sample t-tests were used to compare mean scores of personality traits compared to normative data [39, 40] (Table 2). All tests were 2-tailed (Pearson chi-square) using IBM SPSS Statistics for Windows (Version 27).

Results

Demographics

186 certified colorectal surgeons participated in the personality testing with 127 (68.3%) completing both parts (i.e., also completed the anastomotic scenarios). 131 participants were male (70.4%), with 77 surgeons (41.4%) becoming fully qualified within the last 5 years. Surgeons from 22 countries completed Part 1, with the majority practicing in Europe (UK, n = 78 (41.9%); Western Europe, n = 43 (2~~1~~3.1%); Eastern Europe, n = 23 (12.4%)) (Table 1).

Surgical Decisions & Personality

No participants were excluded due to incompletion of Big Five Inventory items. Surgeons scored higher than worldwide general populations for emotional stability (3.25 vs 3.00, $p < 0.001$) and had lower levels of agreeableness (3.03 vs 3.56, $p < 0.001$), extraversion (2.81 vs 3.38, $p < 0.001$) and openness (3.19 vs 3.70, $p < 0.001$) [39, 40] (Tables 2 & 3). There were no differences in conscientiousness in comparison to the general population. The worldwide demographics of general population personality traits are summarized in Table 2 for context [39, 40].

Specific traits influenced anastomotic decision-making in some settings. Higher rates of stoma formation were associated with higher levels of openness when providing a second opinion ($p < 0.050$, Scenario 6 - Appendix 3). Extraverted surgeons were more likely to have their anastomotic decision-making influenced when operating on a colleague (Scenario 6, Appendix 3; $\rho = 0.192$, $p = 0.030$) (Table 4). Variation in practice amongst experts was confirmed by varied responses to patient-specific scenarios (Table 5) – there were only three scenarios were surgeons almost unanimously agreed to stoma formation (Scenarios 2, 4 and 5, Appendix 4).

Surgical Decisions & Gender

Of the five personality traits, only openness to experience differed between male (n = 131) and female surgeons (n = 54), with female surgeons having significantly lower levels (3.06 vs 3.25, $p < 0.001$). These findings are summarized in Tables 3 and 4.

127 surgeons completed the anastomotic scenarios, with 90 male surgeons and 37 female surgeons. Of the scenarios investigating surgeon factors (Appendix 3), female surgeons were significantly more likely than males to be influenced by recent personal criticism at a departmental meeting regarding an anastomotic decision where the patient leaked but survived ($p = <0.010$) and when they witnessed a colleague being criticized for the same scenario ($p = 0.020$). Male surgeons with higher levels of extraversion were significantly more likely than females to be influenced by criticism at a recent morbidity and mortality meeting following an anastomotic leak ($p = 0.018$) or following a recent unexpected elective mortality from an anastomotic leak ($p = 0.046$).

Only one scenario investigating patient factors and surgeon risk-taking had a significant effect for gender (Appendix 4), with male surgeons reporting an increased likelihood of selecting the high-risk option (primary anastomosis; no stoma) for Scenario 2, Appendix 4 ($\chi 2_{(2)}$ 10.02, $p = .007$), where the patient had a low rectal cancer (close to sphincters) and partial response to neoadjuvant chemoradiotherapy.

Surgical Decisions & Age / Experience

When comparing surgeon age with personality, the only Big Five personality trait difference was found in openness to experience, with surgeons aged 30-39 years having higher levels of openness (3.27) compared to surgeons aged 50-59 years who had lower levels (3.08) (Table 3). Early career surgeons (qualified within last five years) had higher levels of extraversion than surgeons with established practice (2.88 vs 2.76, p = <0.006).

Surgeons who were highly influenced in their decision-making by a recent 'good run' of no anastomotic leaks (Scenario 5, Appendix 3), tended to be younger in age (ρ = -.190 p = .033). In situations where a close colleague had recently been heavily criticized for an anastomotic leak where the patient died (Scenario 7, Appendix 3) or when the patient survived (Scenario 9, Appendix 3), surgeons with less experience were more likely to be influenced in their anastomotic decision-making based on their colleague's experiences (ρ = -.260 p = 0.003 & -.237, p = 0.007 respectively). Surgeons with less experience were highly influenced by recent personal criticism of anastomotic leakage where the patient survived (Scenario 1, Appendix 3) and following an unexpected death following an anastomotic leak (Scenario 2, Appendix 3) (ρ = -.229 p = 0.009 & -.214, p = 0.015 respectively).

No correlation was seen between experience (i.e.. early career surgeons versus established surgeons) with risky choices within the patient factors scenarios (Appendix 4). However, increasing age was associated with higher risk-taking in the emergency setting, including where a patient with a mid-rectal cancer presents with impending obstruction and liver metastases (Scenario 3, Appendix 4), where surgeons aged 50-59 years old were significantly more likely to perform anastomose primarily without stoma formation ($\chi 2_{(6)}$ 13.04, p =0.041).

Discussion

~~In~~ This ~~this~~ international survey~~, we~~ has demonstrated that variation in surgical decision-making is influenced by the personality of the surgeon. Variation in surgical practice was confirmed by consensus about anastomotic decision making in only three scenarios (scenarios 2, 4 and 5 – Appendix 4), where there was unanimous agreement to form a stoma. Two of these scenarios indicated strong patient preferences for stoma avoidance that the

surgeons overruled. However, this is not to suggest that surgeons do not consider the patient's wishes important – rather they considered the documented risk of poorer bowel function or anastomotic leak risk to be of greater importance than the risk of forming a stoma. All personality traits may be beneficial and/or detrimental when subjected to specific settings or environmental circumstances (termed trait activation theory) [11], which may explain our finding that there was no single unifying personality trait which influenced primary anastomosis, temporary stoma formation, or permanent diversion with colostomy across all scenarios, but that specific traits influenced individual scenarios (e.g. extraversion influenced decision-making when providing a second opinion). The secondary aim of this work was to identify traits which may influence patient care and post-operative outcomes. Patients have previously indicated that they believe the surgeon's personality influences their peri-operative care, identifying high levels of emotional stability and conscientiousness as preferable [41]. ~~Our~~ This study demonstrated that surgeons appear to possess these traits, however a direct relationship between these specific traits and post-operative outcomes is yet to be established.

Colorectal surgeons had higher levels of emotional stability (even-temperedness) than the general population and possessed lower than average levels of agreeableness (tendency towards conflict), extraversion (tendency towards enthusiasm, assertiveness) and openness to experience (tendency towards fixed thinking, routine), with some support for findings from a recent systematic review on abdominal surgeon personality (high levels of conscientiousness) [15]. Interestingly, female surgeons had lower levels of openness in comparison to male surgeons, differing from what is commonly found in the general population [35, 36]. Thus, this study builds upon previous work demonstrating that colorectal surgeons may have differing personality traits to the general population [14, 15], whilst demonstrating that the surgeon's personality is an independent factor influencing variation in decision-making - a novel finding. ~~Our~~ The finding that early career surgeons and female surgeons are highly influenced by recent personal or witnessed criticism in anastomotic decision-making highlights the importance of a supportive working environment, particularly in the morbidity and mortality meeting setting [42]. This may be a result of cognitive appraisal (contributing to anecdotal experience), where the personal interpretation of an event influences the emotional response from the individual [43, 44].

With increasing experience, surgeons report less intra-operative stress and subsequently improved performance compared to less experienced colleagues, which may explain the susceptibility to criticism in early career surgeons [45]. Given this information, early career surgeons and female surgeons are likely to benefit from appropriate mentorship throughout one's career [46].

This is the first study to report on gender analysis of a global cohort of colorectal surgeons in relation to personality traits. A recent study garnering much media interest suggested that the surgeon's gender accounted for variation in patient post-operative outcomes [47]. ~~Our~~ This work would suggest that this may be an over-simplification, with differences arising from the individual's risk perceptions and inherent personality traits, as well as surgeon demographics (including years of experience and gender) in the face of specific clinical situations. Surgical decision-making (and thus, post-operative outcomes) is likely to be far more complex than the genders of those involved, as demonstrated by ~~our~~ the findings of this work~~study findings~~. Interestingly, the study by Wallis et al. which suggested that surgeon gender influences patient outcomes failed to demonstrate this in emergent surgery – a setting where cases are allocated irrespective of training, age, experience, and gender [47]. High-risk decisions with uncertainty are likely to be influenced by the subjective perceptions of the surgeon and their comfort of risk-taking. For example, risk-taking is influenced by the characteristics of the person (including personality, demographics), the specific situation and the perceived reward from taking that risk [48]. While risk-taking and personality are inter-related, they are separate constructs and the relationship between risk-taking and anastomotic decision-making merits further investigation.

Personality has been demonstrated to change throughout one's medical career: from medical students throughout their undergraduate degree [49], postgraduate training [50], as well as following retirement [51]. Therefore, the personality changes seen throughout one's life could be hypothesized to be a cumulative result of life experiences, for example, increasing clinical experience in response to various 'successes' or 'failures' in a surgical career [3, 51, 52] and may explain the relationship between experience and decision-making in response to an anastomotic leak~~.~~ ~~This may explain our findings of experience and decision-making in response to an anastomotic leak.~~ Periodic personality testing throughout a medical career

could potentially have a role in mapping the needs of surgeons as their training progresses and experience increases. This may increase the awareness amongst surgeons of the implications of the individual's personality on clinical risk-taking and potentially influence patient outcomes.

Limitations

With any opt-in survey, selection bias of participants may be present. Responses may be subject to social desirability bias or the participant's lack of insight into their 'true self'. However, psychometric testing is generally considered to be reliably answered in 'non-examined' unpressurised circumstances [53]. As invitations were distributed via social media, it is unknown what the true denominator of participants meeting the inclusion criteria was, thus the response rate is incalculable. The use of social media as the primary recruitment strategy also means it is possible that this cohort of relatively younger surgeons are more interested in participating in personality trait analysis than those who are older, or those who do not engage with social media for professional or educational purposes. There was also a significant discrepancy between the number of male and female surgeons who participated; however, this is likely to reflect the current colorectal surgeon workforce. An imbalance of surgeons participating from all over the globe meant that for analysis, some countries were grouped into regions. This assumption may therefore not be strictly representative of individual countries however comparisons are available in Table 2 [38, 39]. Given these low numbers per country, it was not possible to correlate risk-taking decision-making with country of practice. There was also a significant proportion of surgeons (31.7%) who completed Part 1 but did not complete Part 2 of the survey.

Conclusion

Colorectal surgeons possess personality traits which patients have previously identified as 'preferable' (emotional stability, conscientiousness). Surgeon personality influences anastomotic decision-making in certain settings. As risk perception is unique to the individual when exposed to specific circumstances, further work is necessary to determine

other key cognitive factors which influence surgical decision-making under uncertainty. Improved understanding of how personality traits and risk-taking preferences may influence decision-making demands further investigation, due to its suspected influence upon shared decision-making with patients and subsequently, post-operative outcomes.

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Contributions

Ethics: CNB, EF, ND, RO, SP, JC, SJM.

Concept & Study Design: CNB, NF, EF, JC, SP, RO, ND, SJM.

Survey Design: CNB, EF, NY, EM, SS, DK, ND, RO, SP, JC, SJM.

Data Collection & Analysis: CNB, EF, SJM.

Paper Drafting and Editing: all authors.

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Appendix 1: Checklist for Reporting Results of Internet E-Surveys (CHERRIES)

Item Category	Checklist Item	Page
Design	Describe survey design	6
Ethical approval and informed consent process	IRB approval	6
	Informed Consent	6
	Data Protection	6
Development and pre-testing	Development and testing	7
Recruitment Process and description of the sample having access to the questionnaire	Open survey vs closed	6-7
	Contact mode	6
	Advertising the survey	6
Survey Administration	Web/Email	6
	Context	7
	Mandatory/Voluntary	7
	Incentives	7
	Time/Date	7
	Randomisation of items/questionnaires	N/A
	Adaptive questioning	8-9
	Number of Items	8-9
	Number of pages / screens	Not reported
	Completeness check	8
	Review Step	8
Response Rates	Unique site visitor	N/A
	View Rate	N/A
	Participation rate	N/A
	Completion Rate	9
Preventing multiple entries from the same individual	Cookies used	N/A
	IP Check	N/A
	Log file analysis	N/A
	Registration	N/A
Analysis	Handling of incomplete questionnaires	7-8
	Questionnaires submitted with an atypical timestamp	N/A
	Statistical correction	9

APPENDIX 2: BIG FIVE INVENTORY PERSONALITY INDEX

Here are a number of characteristics that may or may not apply to you. Please select a number next to each statement to indicate the extent to which you agree or disagree with that statement.

1 = Disagree Strongly
2 = Disagree a little
3 = Neither agree nor disagree
4 = Agree a little
5 = Agree Strongly

I see myself as someone who is:

1. Is talkative
2. Tends to find fault with others
3. Does a thorough job
4. Is depressed, blue
5. Is original, comes up with new ideas
6. Is reserved
7. Is helpful and unselfish with others
8. Can be somewhat careless
9. Is relaxed, handles stress well
10. Is curious about many different things
11. Is full of energy
12. Starts quarrels with others
13. Is a reliable worker
14. Can be tense
15. Is ingenious, a deep thinker
16. Generates a lot of enthusiasm
17. Has a forgiving nature
18. Tends to be disorganised
19. Worries a lot
20. Has an active imagination
21. Tends to be quiet
22. Is generally trusting
23. Tends to be lazy
24. Is emotionally stable, not easily upset
25. Is inventive
26. Has an assertive personality
27. Can be cold and aloof
28. Perseveres until the task is finished
29. Can be moody
30. Values artistic, aesthetic appearances
31. Is sometimes shy, inhibited
32. Is considerate and kind to almost everyone
33. Does things efficiently
34. Remains calm in tense situations
35. Prefers work that is routine
36. Is outgoing, sociable
37. Is sometimes rude to others
38. Makes plans and follows through with them
39. Gets nervous easily
40. Likes to reflect, play with ideas
41. Has few artistic interests
42. Likes to cooperate with others
43. Is easily distracted
44. Is sophisticated in art, music or literature

Scoring (R denotes reverse scored items):

Extraversion: 1, 6R, 11, 16, 21R, 26, 31R, 36
Agreeableness: 2R, 7, 12R, 17, 22, 27R, 32, 37R, 42
Conscientiousness: 3, 8R, 13, 18R, 23R, 28, 33, 38, 43R
Emotional Stability: 4, 9R, 14, 19, 24R, 29, 34R, 39
Openness: 5, 10, 15, 20, 25, 30, 35R, 40, 41R, 44

APPENDIX 3: SURGEON FACTORS DELPHI

The following short scenarios are intended to focus on your instinctive decision-making, with the focus away from specific patient factors. They intentionally provide limited information for this purpose.

When considering decision-making in 'normal', non-COVID times, to what extent do the following scenarios influence your next anastomotic decision? (i.e. to what extent do the factors in each scenario play on your mind for your *next* case?)

(1 – Extremely unlikely to influence; 5 - Neutral; 10 – Extremely likely to influence)

i. You were heavily criticised at the last morbidity and mortality meeting for performing an anastomosis in an elective patient who had a leak and survived.
ii. Within the last 30 days, you have had an unexpected elective mortality following the death of a patient after an anastomotic leak.
iii. You have a patient who has frequent admissions with acute kidney injury and electrolyte disturbance due to a high output ileostomy after elective surgery 3 months ago. She is currently an inpatient.
iv. You are working with an anaesthetist who you personally have only worked with once before, and from that list, had an unexpected elective patient death – presumed to be from a sudden cardiac event.
v. Despite being very busy, you haven't had an anastomotic leak for 12 months.
vi. Your next patient is a nurse on one of the surgical wards in your hospital, who has specifically approached you to take their case on.
vii. Your colleague was heavily criticised at the last department morbidity and mortality meeting following the death of an elective patient whose anastomosis leaked.
viii. A patient (needing a low anterior resection for rectal cancer) has been transferred to your care for a second opinion after having neoadjuvant chemo-radiotherapy. They are lodging a complaint against the first surgeon, but you do not know the details.
ix. Your colleague was heavily criticised at the last department morbidity and mortality meeting for performing an anastomosis in a comorbid elective patient which leaked. The patient survived and is now out of hospital.
x. You performed an elective Hartmann's procedure on a frail and comorbid older patient. Somewhat surprisingly, the patient recovered extremely well from surgery with no immediate post-operative problems. This operation was intended to be the definitive treatment (i.e. you are not planning on Hartmann's reversal). Your next case is very similar.

APPENDIX 4: PATIENT FACTORS DELPHI

We present 7 hypothetical scenarios involving patient factors. The scenarios are designed to be ambiguous with only some details provided, therefore they are open to interpretation.

1. A 70-year-old female presents as an emergency with acute lower abdominal pain, localised peritonism to the left iliac fossa, with blood tests demonstrating a C-Reactive Protein level of 320 (normal <20). She smokes, has hypertension and has a BMI of 30. Her CT scan shows extensive fluid and gas with a retroperitoneal upper rectal perforation, with no gross contamination elsewhere within the peritoneal cavity. This is proximal to a stricturing upper 1/3 rectal tumour. At laparotomy a retroperitoneal pelvic collection containing faeces was encountered with the known retroperitoneal upper rectal perforation visualised.
   Primary anastomosis; no stoma
   Primary anastomosis; defunctioning ileostomy
   Hartmann's
   Stoma formation; no resection
   Other

2. A 57-year-old man who has no documented medical comorbidities, had a low rectal cancer picked up by bowel screening. He has a BMI of 30 and has completed neoadjuvant chemoradiation with a marginal/partial response and has confirmed residual disease on MRI 2cm above the sphincters (currently staged as T2). He is absolutely against the idea of a stoma.
   Primary anastomosis; no stoma
   Primary anastomosis; defunctioning ileostomy
   Hartmann's
   Other

3. An otherwise fit 50-year old male is admitted as an emergency with lower abdominal pain, weight loss and PR bleeding. He states he last opened his bowels yesterday. CT of his chest, abdomen and pelvis demonstrates a stricturing mid-rectal cancer which is not currently; but is at high risk of becoming obstructed. His CT suggests he has 2 liver metastases in the same lobe, which would be technically resectable. MRI confirms mid-rectal tumour that is not margin-threatening.
   Primary anastomosis; no stoma
   Primary anastomosis; defunctioning ileostomy
   Hartmann's
   Endoscopic stent
   Stoma formation; no resection
   Other

4. There have been multiple delays to your operating list, with difficulties getting a high dependency unit bed secured for your 60-year old patient, who has a mid-rectal cancer. You therefore start the case much later than anticipated. During surgery, your trainee was mobilising the sigmoid colon under your supervision. You are called into a colleague's adjacent operating theatre for a second opinion. While you are out of the room, you give permission for your trainee to continue with the case: "just be careful". You return to your theatre 15 minutes later. However, it becomes clear to you on closer inspection that the ureter has been inadvertently injured. Urology are called and the ureter is primarily repaired, and a stent is placed. No urine is leaking. The remainder of the dissection and surgery is uneventful.
Primary anastomosis; no stoma
Primary anastomosis; defunctioning ileostomy
Hartmann's
Other

5. A 38-year old male patient attends clinic with his new partner. He has an impalpable ultra-low rectal tumour and had neoadjuvant chemoradiotherapy given with some response (incomplete). He has consented to a defunctioning loop ileostomy, however this was with great reluctance and after much discussion because of his concerns that surgery may affect his new relationship. His TME was challenging due to pelvic side wall bleeding, which was controlled by packing the pelvis, suture ligating the problematic vessels. He was given a blood transfusion intra-operatively. You are happy that the pelvis is now dry, the resection has been completed satisfactorily and the leak test is negative.
Primary anastomosis; no stoma; no drain
Primary anastomosis; no stoma; pelvic drain placed
Primary anastomosis; defunctioning ileostomy; no drain
Primary anastomosis; defunctioning ileostomy; pelvic drain placed
Hartmann's
Other

6. A 63-year old female (fit and well) is referred as an emergency from her family doctor / GP with constipation, bloating and abdominal pain, and on CT scan is found to have a large bowel obstruction secondary to an upper rectal cancer and no metastases. She is still passing flatus. At the time of surgery, her colon is faecally loaded, which is amenable to on-table lavage. However, the tumour looks to be locally advanced and arises posteriorly. You are concerned that this breaches the posterior TME plane.
Primary anastomosis; no stoma
Primary anastomosis; defunctioning ileostomy
Hartmann's

Endoscopic stent
Stoma formation; no resection
Other

Although the focus of our study is in non-pandemic circumstances, for the following 2 scenarios, we are focusing on some COVID-specific cases.

7. An otherwise fit 50-year old male is admitted as an emergency with lower abdominal pain, weight loss, pyrexia and PR bleeding. He states he last opened his bowels yesterday. CT of his chest, abdomen and pelvis demonstrates a stricturing mid-rectal cancer which is not currently; but is at high risk of becoming obstructed. He had a COVID swab sent due to his temperature, which has returned as a positive result. His CT suggests he has 2 liver metastases in the same lobe, which would be technically resectable.
Primary anastomosis, no stoma
Primary anastomosis with defunctioning ileostomy
Hartmann's procedure
Stoma formation with no resection
Other

8. A 57-year old man who has no documented medical comorbidities, had a low rectal cancer picked up by bowel screening. He had symptomatic COVID-19 in the last 4 weeks, has recovered fully and has since had 2 negative swabs as part of his pre-assessment. He has been shielding for 2 weeks. He has a BMI of 30 and has completed neoadjuvant chemoradiation with a marginal/partial response and has confirmed residual disease on MRI 2cm above the sphincters (staging is provisionally T2). He is absolutely against the idea of a stoma.
Primary anastomosis, no stoma
Primary anastomosis with defunctioning ileostomy
Hartmann's procedure
Stoma formation with no resection
Other

9. At the peak of the pandemic thus far in your respective region, to what extent did high population levels of COVID-19 influence your anastomotic decision?
(1 – Extremely unlikely to influence; 10 – Extremely likely to influence)

10. In this last case, *you* are now the patient. For the purposes of this scenario, you have no significant comorbidities that would preclude you from surgery or that would make you consider a Hartmann's procedure.

    You have a mid-rectal cancer with no metastases, and have had neoadjuvant chemoradiotherapy for margin threatening disease. Prior to your clinic consultation

you have made up your mind about what surgery you would prefer. You have not yet approached your consultant colleagues; but have the choice of Surgeon 1 who does not routinely form ileostomies (and tends to anastomose primarily) or Surgeon 2 who frequently forms temporary ileostomies when performing rectal cancer surgery.

Who would you prefer to operate on your rectal cancer?
Surgeon 1 – tends to anastomose primarily (fewer stomas)
Surgeon 2 – tends to defunction regularly

Table 1: Demographics of Colorectal Surgeons in the Plato Project

Demographics	*Number of Participants (n = 186)*	*Cohort Total (%)*
Gender		
Male	*131*	*70.43*
Female	*54*	*29.03*
Prefer Not to Say	*1*	*0.01*
Age		
30 – 39	*61*	*32.80*
40 – 49	*82*	*44.109*
50 – 59	*36*	*19.435*
60 – 69	*5*	*2.769*
70+	*2*	*1.108*
Certification Experience		
Within 12 months	*21*	*11.329*
1 – 3 years	*22*	*11.83*
3 – 5 years	*34*	*18.328*
5 – 10 years	*48*	*25.81*
10 – 15 years	*29*	*15.659*
15 – 20 years	*16*	*8.60*
20+ years	*16*	*8.60*
Region of Practice		
UK	*78*	*41.94*
Western Europe	*43*	*23.12*
Eastern Europe	*23*	*12.437*
North America	*10*	*5.438*
Australasia	*10*	*5.438*
Central Asia	*9*	*4.84*
Rest of the World	*13*	*7.06.99*

Table 2: Mean surgeon Big Five Inventory Scores versus selected world population samples*~

Domain	Colorectal Surgeons	Eastern Europe [39]	Western Europe [39]	USA [40]	East Asia [39]	Middle East [39]	Oceania [39]	One Sample t-test
Extraversion	2.81	3.42	3.38	3.24	3.16	3.40	3.42	$t_{(185)} = -18.97$, $p < .001$
Agreeableness	3.03	3.54	3.56	3.89	3.40	3.78	3.66	$t_{(185)} = 36.34$, $p < .001$
Conscientiousness	3.42	3.38	3.40	3.79	3.08	3.58	3.60	$t_{(185)} = -7.63$, $p < .001$
Emotional Stability	3.25	2.92	3.00	3.1	3.30	2.98	2.94	$t_{(185)} = 12.99$, $p < .001$
Openness	3.19	3.72	3.70	3.89	3.34	3.78	3.70	$t_{(185)} = -20.97$, $p < .001$

***5 point scale - minimum 1 (low levels); maximum 5 (high levels)**

~ Further regional comparisons are available via Schmitt reference

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Table 3: Association between personality and demographics

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Variable		Extraversion	Openness	Conscientiousness	Agreeableness	Emotional Stability
Gender	Female (n = 54)	2.75 (0.34)	**3.06 (0.34)**	3.37 (0.43)	3.03 (0.26)	3.25 (0.32)
	Male (n =131)	2.83 (0.29)	**3.24 (0.28)**	3.44 (0.40)	3.02 (0.27)	3.25 (0.29)
		p = .066	**p = .001**	p = .278	p = .770	p = .961
Age Range	30-39 (n = 61)	2.85 (0.32)	**3.27 (0.32)**	3.43 (0.36)	2.99 (0.25)	3.26 (0.27)
	40-49 (n = 82)	2.82 (0.28)	3.19 (0.31)	3.43 (0.43)	3.02 (0.28)	3.23 (0.32)
	50-59 (n = 36)	2.73 (0.35)	**3.08 (0.28)**	3.31 (0.44)	3.09 (0.26)	3.25 (0.31)
	60+ (n = 7)	2.69 (0.26)	3.10 (0.20)	3.71 (0.24)	3.00 (0.30)	3.36 (0.18)
		p = .215	**p = .019** **59-59<30.39**	p = .092	p = .405	p = .717
Years of Practice	Early Career Surgeon (<5 years) n = 77	**2.88 (0.28)**	3.23 (0.33)	3.46 (0.35)	2.99 (0.24)	3.28 (0.30)
	Established Surgeon (>5 years) n = 109	**2.76 (0.32)**	3.16 (0.29)	3.39 (0.45)	3.05 (0.28)	3.23 (0.29)
		p = .006	p = .063	p = .152	p = .093	p = .141

Table 4: Correlations with personality and surgeon factor anastomotic scenarios (Appendix 3)

Correlations with Surgeon Factor Scenarios (Appendix 3)													
		Scenarios	1	2	3	4	5	6	7	8	9	10	~~11~~
Spearman's Rho	Extraversion	Correlation Coefficient	.112	.134	-.067	.043	.156	**.192***	.132	.082	.115	.106	~~0.83~~
		Sig. 2-tailed	.206	.132	.453	.628	.079	0.30	.137	.356	.197	.231	~~.352~~
		Number (n)	129	128	128	129	127	128	128	128	128	129	~~129~~
	Male	Correlation Coefficient	**.246***	**.210***	-.047	.100	.109	***.248**	.159	.106	.156	.062	
		Sig. 2-tailed	.018	.046	.654	.343	.303	.018	.132	.316	.140	.555	
		Number (n)	92	91	92	92	91	91	91	91	91	92	
	Female	Correlation Coefficient	-.068	.025	-.107	-.070	**.353***	.088	.108	.134	.151	.265	
		Sig. 2-tailed	.691	.881	.536	.679	.035	.603	.526	.430	.371	.113	
		Number (n)	37	37	36	37	36	37	37	37	37	37	
	Agreeableness	Correlation Coefficient	0.12	-.010	-0.41	.056	.0.10	.015	.047	-0.82	.002	.050	~~.142~~
		Sig. 2-tailed	.895	.908	.649	.526	.908	.870	.602	.355	.978	.577	~~.108~~
		Number (n)	129	128	128	129	127	128	128	128	128	129	~~129~~
	Male	Correlation Coefficient	-.064	-.027	.017	.103	.103	-.036	.018	-.121	-.047	.034	
		Sig. 2-tailed	.542	.801	.876	.331	.331	.734	.865	.253	.655	.748	
		Number (n)	92	91	92	92	92	91	91	91	91	92	
	Female	Correlation Coefficient	.165	-.032	-.211	-.039	.144	-.032	.089	.008	.111	.102	
		Sig. 2-tailed	.329	.853	.217	.818	.401	.851	.602	.962	.512	.547	
		Number (n)	37	37	36	37	36	37	37	37	37	37	
	Conscientious-ness	Correlation Coefficient	-.058	-.076	-.056	-.043	-.082	-.131	-.082	-.039	-.051	-.018	~~.045~~
		Sig. 2-tailed	.517	.396	.531	.628	.362	.141	.355	.659	.568	.836	~~.614~~
		Number (n)	129	128	128	129	127	128	128	128	128	129	~~129~~
	Male	Correlation Coefficient	.018	.029	-.075	.022	-.089	.000	.028	.033	-.008	-.023	
		Sig. 2-tailed	.862	.783	.478	.835	.400	.998	.789	.758	.758	.830	
		Number (n)	92	91	92	92	91	91	91	91	91	92	
	Female	Correlation Coefficient	-.073	-.215	.075	-.180	-.034	**.342***	-.294	-.121	-.030	-.006	
		Sig. 2-tailed	.668	.202	.664	.286	.845	.038	.077	.474	.860	.973	
		Number (n)	37	37	36	37	36	37	37	37	37	37	
	Emotional Stability	Correlation Coefficient	.132	-.025	-.032	-.101	.134	.077	.057	.006	.081	-0.41	~~.090~~
		Sig. 2-tailed	.135	.780	.722	.254	.134	.389	.525	.950	.366	.647	~~.312~~
		Number (n)	129	128	128	129	127	128	128	128	128	128	~~129~~
	Male	Correlation Coefficient	**.207***	-.017	-.031	-.055	.033	.099	.078	-.030	.073	.089	
		Sig. 2-tailed	.048	.870	.766	.600	.755	.349	.460	.780	.493	.401	
		Number (n)	92	91	92	92	91	91	91	91	91	92	
	Female	Correlation Coefficient	-.187	-.134	-.059	-.194	**.358***	-.029	-.080	.078	.006	.252	
		Sig. 2-tailed	.268	.429	.734	.250	.032	.865	.638	.647	.973	.133	
		Number (n)	37	37	36	37	36	37	37	37	37	37	
	Openness	Correlation Coefficient	-.107	-.168	-.051	.004	.021	-.172	-.016	**.178***	-.058	-.041	~~-.074~~
		Sig. 2-tailed	.228	.059	.568	.966	.814	.052	.858	.045	.512	.647	~~.404~~
		Number (n)	129	128	128	129	127	128	128	128	128	129	~~129~~
	Male	Correlation Coefficient	.021	-.044	-.092	.060	.098	-.121	.045	-.067	-.022	.060	
		Sig. 2-tailed	.842	.676	.382	.567	.354	.255	.675	.528	.835	.573	
		Number (n)	92	91	92	92	91	91	91	91	91	92	
	Female	Correlation Coefficient	.013	-.242	.202	-.109	-.085	-.311	-.042	**-.408***	.109	-.248	
		Sig. 2-tailed	.937	.149	.236	.522	.624	.061	.807	.012	.520	.139	
		Number (n)	37	37	36	37	36	37	37	37	37	37	

*correlation is significant at 0.05 level (2-tailed)

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Table 5: Surgeon Responses to Risk-Taking Scenarios (Appendix 4)

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		1	2	3	4	5	6	7	8
Low Risk	Frequency (n)	94	2	41	4	4	62	39	7
	Percent %	73.4	1.7	36.0	3.1	3.2	49.6	37.9	6.0
Medium Risk	Frequency (n)	33	96	52	125	109	46	60	87
	Percent %	25.8	79.3	45.6	96.9	87.9	36.8	58.3	75.0
High Risk	Frequency (n)	1	23	21	N/A	11	17	4	22
	Percent %	0.8	19.0	18.4		8.9	13.6	3.9	19.0
Total	Number of Surgeons	128	121	114	129	124	125	103	116