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An International Assessment of the Adoption of Enhanced Recovery After Surgery (ERAS®) Principles Across Colorectal Units in 2019/20

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ABSTRACT (249/250 words)

Aim

The Enhanced Recovery After Surgery (ERAS[®]) Society guidelines aim to standardise perioperative care in colorectal surgery via 25 principles. We aimed to assess the variation in uptake of these principles across an international network of colorectal units.

Method

An online survey was circulated amongst European Society of Coloproctology members in 2019/20. For each ERAS[®] principle, respondents were asked to score how frequently the principle was implemented in their hospital, from 1 ('rarely') to 4 ('always'). Respondents were also asked to recall whether practice had changed since 2017. Subgroup analyses based on hospital characteristics were conducted.

Results

Of hospitals approached, 58% responded to the survey (195/335), with 296 individual responses (multiple responses were received from some hospitals). The majority were European (163/195 [83.6%]). Overall, respondents indicated they 'most often' or 'always' adhered to most individual ERAS[®] principles (18/25 [72%]). Variability in uptake of principles was reported, with universal uptake of some principles (e.g., prophylactic antibiotics; early mobilisation) and inconsistency from 'rarely' to 'always' in others (e.g., no nasogastric intubation; no preoperative fasting and carbohydrate drinks). In alignment with 2018 ERAS[®] guideline updates, adherence to principles for prehabilitation, managing anaemia, and postoperative nutrition appears to have increased since 2017.

Conclusions

Uptake of ERAS[®] principles varied across hospitals, and not all 25 principles were equally adhered to. Whilst some principles exhibited a high level of acceptance, others had a wide variability in uptake indicative of controversy or barriers to uptake. Further research into specific principles is required to improve ERAS[®] implementation.

WHAT DOES THIS PAPER ADD TO THE LITERATURE? (43/50 WORDS)

This study describes uptake of individual Enhanced Recovery After Surgery® principles in colorectal surgery across an international network and identifies variability in adherence across centres. By better understanding the barriers to adoption, improvements in uptake may occur, leading to improved outcomes for patients.

INTRODUCTION

Colorectal resection is an important and potentially curative intervention for patients with either colorectal cancer or inflammatory bowel disease [1, 2]. However, resection is associated with a high degree of patient burden in the short-term, in terms of length-of-stay, re-admission rates and the risk of severe complications like anastomotic leak [3, 4]. Furthermore, clinical care of patients undergoing colorectal surgery differs between hospitals and countries, with considerable variation in length-of-stay, recovery times and complication rates [5, 6]. These factors prompted the development of a standardised enhanced recovery protocol: the Enhanced Recovery After Surgery (ERAS®) Society guidelines [5].

The first ERAS® guidelines for colorectal surgeons were published in 2005 [5]. The most recent (fourth) version was published in 2018, including the addition of guidelines for prehabilitation, preoperative nutritional care, management of anaemia, preoperative euvolaemia and postoperative euvolaemia [7]. These latest ERAS® Society guidelines include 25 evidence-based principles designed to reduce perioperative stress, maintain physiological functioning postoperatively, and accelerate surgical recovery [7]. While there is extensive research to suggest that a multi-modal approach can reduce morbidity rates, improve recovery and shorten hospital length-of-stay after major colorectal surgery [8-11], there is limited research on the international adoption of these principles.

The effectiveness of certain principles contained within in the ERAS® guidelines are also a source of debate; for example the optimal preoperative bowel preparation regimen remains controversial [12, 13]. Currently, the ERAS® guidelines recommend that preoperative mechanical bowel preparation should not be used routinely in colorectal surgery due to the risk of adverse events and lack of evidence for an associated benefit [14-18]. However, recent studies investigating mechanical bowel preparation alongside oral antibiotics have demonstrated an apparent benefit in the reduction of anastomotic failure [12, 19].

The objectives of this study were to assess uptake and variation in adherence to individual ERAS® principles in 2019/20 and to assess the change in practice as compared to 2017 across international centres. By better understanding uptake and variation, patient recovery following colorectal surgery may be harmonised between surgical centres in the future. This is likely to result in improved outcomes for patients.

METHOD

Study design

A closed, online survey was circulated to all members who had actively participated in the 2017 European Society of Coloproctology (ESCP) snapshot audit of Left Colon, Sigmoid and Rectal Resections [20]. This group comprised healthcare professionals at 335 participating sites across 49 countries. The voluntary survey was in English and remained open from 21st November 2019 to 6th March 2020.

Study data were collected and managed using REDCap (Research Electronic Data Capture) electronic data capture tools hosted at the University of Birmingham, UK [21, 22]. For further details on the online survey and database, see the **Supplementary Appendix**.

The snapshot audit study database was used to extract hospital centre characteristics including geographic region, as defined by the United Nations M49 Standard [23], World Bank income status [24], type of hospital (university/tertiary versus community) and hospital capacity [20].

Participants and study evaluations

The survey included two questions on each of the 25 ERAS[®] principles with four possible responses per question (**Error! Reference source not found.**). For this online survey, all questions were distributed on one page. Respondents were required to report their current practice (2019/20) and to recall their practice from 2017.

Two questions were asked per principle, the first of which was on a Likert scale and the second a nominal scale. The first question sought to determine the proportion of colorectal procedures which adhered to each principle (2019/20). Respondents were able to choose 'Rarely (0–25%)', 'Sometimes (26–50%)', 'Most often (51–75%)' or 'Always (76–100%)', with percentages relating to the proportion of procedures for which the principle was believed to be implemented in their hospital. The second question queried whether adherence for that principle was the same in 2017 (according to respondent recall) compared to 2019/20. Response options were 'Do not know', 'No, did it more often in 2017', 'Yes', or 'No, did it less often in 2017'.

Statistical analysis

Only respondents who provided an answer to the survey were considered in the analysis. The responses to the survey were converted to numerical values on a scale of 1–4, as found in **Table 1**. The mean for overall proportion of ERAS® principles adhered to 'most often' and 'always' as well as the mean uptake score for each ERAS® principle in 2019/20 were calculated. The mean scores for recall of practice from 2017 were also calculated. Variation was assessed by calculating the interquartile range (IQR). For each analysis, principles were ranked based on mean uptake (1: highest mean uptake to 25: lowest mean uptake). Data were analysed using R Studio version 3.6.0. All analyses were descriptive with no formal statistical tests performed.

The primary analysis included all responses, even where multiple responses were provided from one centre. This ensured that variation in uptake was captured, even when this variation derived from different respondents' experience within the same hospital. A secondary analysis was performed, which only included responses from centres where one response was submitted; in this analysis, responses from centres with multiple responses submitted were excluded.

Two subgroup analyses were performed on the 2019/20 responses using the primary analysis to compare the uptake of principles between groups stratified by hospital characteristics: general hospitals versus university/tertiary centres and highest versus lowest capacity (determined via bed number quartiles). As there were very few responses from hospitals in low-income countries or regions outside of Europe, subgroup analyses based on these hospital characteristics were not conducted to avoid biases arising from a small sample size.

RESULTS

Demographics

Eligible hospitals included all members of 2017 ESCP collaborating group (N=335; **Figure 1**). Overall, 58% of centres responded to the survey (195/335), with 70 centres submitting multiple responses, leading to a total of 296 individual responses across all centres (**Figure 1**). Of the 195 responding centres, 186 had complete characteristics data (nine centres had missing identification and so characteristics could not be extracted). The highest proportion of centres originated from Europe (Southern: 75/186 [40.3%]; Northern: 46/186 [24.7%]; Western: 22/186 [11.8%]; Eastern: 20/186 [10.8%]). Non-European centres comprised 23 (12.4%) hospitals

(**Table 2**). The majority of responding hospitals were from countries rated as high income according to World Bank income status (152 [81.7%]) [24].

Practice in 2019/20

Primary analysis

Overall, respondents indicated they 'most often' or 'always' adhered to 18 (72%) of the 25 individual ERAS® principles. Of the individual principles, antibiotic prophylaxis had the highest mean uptake score across all responses (3.83/4), with early mobilisation (3.72), preadmission information, education and counselling (3.56), intraoperative euvolaemia (3.56) and urinary catheter (1–3 days) (3.56), together comprising the five principles with the highest implementation (**Figure 2A**). The five principles with the lowest uptake in 2019/20 were prehabilitation (2.36), no drainage (2.66), no preoperative fasting and carbohydrate drink (2.79), no sedative premedication (2.82) and no preoperative bowel preparation (2.82).

The principles where the highest number of responders reported they 'always' adhered can be found in **Figure 2B**. The principles with the highest variability between responses, with a mean uptake <3, included no nasogastric intubation and no preoperative fasting and carbohydrate drink (IQR 1–4); followed by no drainage, postoperative nutrition, prehabilitation, no preoperative bowel preparation and no sedative premedication (IQR 1–3; **Figure 2C**).

Secondary analysis

The secondary analysis results, which only included hospitals that provided a single response, were largely consistent with the primary analysis. The only difference in the top-five highest mean uptake scores included the addition of intraoperative normothermia in lieu of intraoperative euvolaemia. The secondary analysis included no nasogastric intubation in the lowest five adopted principles, in lieu of no sedative premedication. The mean scores for the principles were similar between the primary and secondary analyses (data not shown).

Recall of 2017 practice

For all but two principles, at least 95% of respondents indicated that they could recall their practice in 2017. The two principles for which more than 5% of respondents did not recall

practice in 2017 were standard anaesthetic protocol and no sedative premedication (8.8% and 5.7% did not recall 2017 practice, respectively).

Overall, the responses indicated little change in practice from 2017 to 2019/20 (**Error! Reference source not found.**). However, there were a few notable exceptions for which responders indicated an increase in adherence from 2017 to 2019/20, including the adoption of prehabilitation, managing anaemia, postoperative nutrition, minimally invasive surgery and preoperative nutrition. For these principles, 41.9%, 32.1%, 30.4%, 29.4% and 27.7% of responders, respectively, reported an increase in adherence in current practice compared with what they recalled from 2017.

The secondary analysis results, which only included hospitals that provided a single response, were also consistent with the primary analysis for the recall of 2017 practice (data not shown).

Subgroup analyses

A subgroup analysis by hospital type highlighted there were minimal differences between general hospitals or university/tertiary centres. Both the ranking of principles and the mean adherence scores were broadly similar across the two hospital types (**Error! Reference source not found.**). The principle with the largest difference in the mean scores in the two subgroups was no drainage which had a 0.43 increase in university centres compared to general hospitals. However, the ranking of this principle was not affected.

An additional subgroup analysis compared the smallest (<400 beds) and largest ($\geq 1,000$ beds) capacity hospital centres. Minimal differences between hospitals were observed in both the ranked list of principles and mean adherence scores between the smallest and largest hospital (by capacity) subgroups (**Error! Reference source not found.**). No drainage had the largest difference in mean (0.43) moving from rank 24 for <400 beds to rank 21 for $\geq 1,000$ beds.

DISCUSSION AND CONCLUSIONS

The ERAS[®] principles are evidence-based guidelines developed to provide a standardised protocol for perioperative care in colorectal operations in order to improve patient outcomes [7]. The aims of this study were to assess the international uptake and variation in adherence of individual ERAS[®] principles in 2019/20 across colorectal surgical centres as well as to evaluate changes in uptake from 2017. Overall, a high level of adherence was reported, with 28% of

ERAS[®] principles 'most often' and 52% 'always' adhered to by respondents. Some principles, such as antibiotic prophylaxis and early mobilisation, display both a high rate of uptake in 2019/20 and a low level of variation across centres, possibly indicating a high degree of acceptance of these principles and limited barriers to uptake.

In contrast, the survey also identified a number of principles that have a high variability in uptake across centres. These principles appear to fall into two categories: those which may be considered emerging practices (prehabilitation, postoperative nutrition and no preoperative fasting and carbohydrate drink) and those where further evidence may be required to reach a consensus on their role in the colorectal surgery care pathway (no drainage, no nasogastric tube, no sedative premedication and no preoperative bowel preparation). For the latter, variation may perhaps reflect the controversial nature of these principles given conflicting evidence over recent years [12, 14-16].

The 42% increase in uptake of prehabilitation between 2017 and 2019/20 aligns with the inclusion of prehabilitation in the 2018 update of the ERAS[®] guidelines [7], suggesting that hospitals are aware of emerging evidence and/or changes in ERAS[®] recommendations, and are open to implementing changes when appropriate. It is possible that many hospitals may also be involved in or aware of recent prospective, randomised research into prehabilitation [25-27], leading to further motivation to improve principle implementation. However, this principle is included as the only item with a "weak" recommendation in the latest guidelines. In this survey, prehabilitation was the principle with the lowest mean uptake, which may reflect this "weak" recommendation. Overall, these data indicate that further research into specific principles may improve uptake with time, especially if evidence emerges of positive outcomes for patients.

In addition to prehabilitation, there were four other principles that were new in the 2018 ERAS[®] guidelines: preoperative nutritional care, management of anaemia, preoperative euvolaemia and postoperative euvolaemia [7]. These newly added principles largely overlap with the principles for which we observed an increase in implementation from 2017 practice, with preoperative nutritional care and management of anaemia among the top five with highest uptake in 2019/20 practice. Increases in adoption of these four principles were also in line with the uptake of minimally invasive surgery (which moved from a low/moderate to high evidence grade in 2018). Minimally invasive surgery had been previously included in the 2012 recommendations; the most recent ERAS[®] guidelines maintained their recommendation, albeit with acknowledgement of

stronger quality of evidence in 2018 [7, 16]. This suggests that the strength of the body of evidence may increase adherence to ERAS® guidelines.

Limitations of the analysis

Whilst this study provides insights into international adoption of ERAS® principles across hospitals, it is important to acknowledge its limitations. Firstly, the study was only distributed amongst members of the ESCP collaborating group, leading to a strong European focus (over 83% of hospitals were within Europe) and relative overrepresentation of university/tertiary hospitals. This has the potential to limit generalisability to other regions of the world. Secondly, given the survey design, the study is subject to response bias from the self-reported nature of the surveyed questions, in addition to recall bias in terms of recalling practice back from 2017. Thirdly, although the study is well-sized to produce an informative indication of adoption across the sample, the number of respondents is insufficient to derive meaningful insights when looking at certain subgroups. These include comparing one country to another as well as comparing high- and low-income countries. Fourth, the answers that respondents could select from for the first survey question, regarding adherence to a principle, used the terms 'most often' (51-75% of the time) and 'always' (76%–100% of the time). Whilst the range of percentages is broad, the four categories were pre-specified, logical divisions, and were deemed the best approach to consider both granularity of response and simplicity of the questionnaire for respondents. Finally, our study highlights specific principles that have the potential for improved adherence, but it does not evaluate whether increased adoption would improve clinical outcomes. Further research is warranted to explore the patient-centric impact of improving adoption to ERAS® principles.

Suggestions on how to standardise adoption of ERAS® principles in the future

The principles with the highest variation in adoption appear to fall into the two categories described above of emerging practices and those where further evidence may be required to reach a consensus on their benefit. For both categories, further research into individual principles may provide an increased degree of consensus. The increase in uptake of the prehabilitation principle from 2017 practice to 2019/20, while still not adopted widely, does demonstrate that principle uptake can improve over time alongside availability of randomised, controlled evidence [25]. Practical insights on how best to increase implementation of emerging principles including prehabilitation, postoperative nutrition, no preoperative fasting and carbohydrate drink may be

found by engaging with the centres which responded to this survey as 'always' implementing these emerging practices.

The principles with a wide variation in uptake that fall into the category where further evidence may be required to reach a consensus include no drainage, no nasogastric tube, no sedative premedication and no preoperative bowel preparation. Some of these principles are controversial as conflicting evidence has prevented widespread acceptance of best practices [12, 14-16]. There may be a role for further research in these key areas in order to reach a consensus on whether adoption does indeed lead to improved outcomes.

Conclusions

There was variation in uptake of ERAS® principles across hospitals, with not all 25 principles adhered to in equal measure. Some principles exhibited a high degree of acceptance, whereas other principles' wide variability in uptake could signify controversy or barriers to uptake. Principles that have seen an increase of adoption in recent years appear to be those with new or strengthening evidence-based recommendations, highlighting that further research into specific principles may modify uptake in time, improving harmonisation of ERAS® practice across hospitals and ultimately leading to better outcomes for our patients.

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Availability of data and materials

All relevant data are within the paper and its Supporting Information files.

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Conflict of interest disclosures

H Taylor, C Tong and N-D Schmitz are employees of Johnson & Johnson and therefore did not participate in the survey.

Ethics approval and consent to participate

No ethical approvals were required for this study.

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TABLES AND FIGURES

Table 1. Survey response codes

Answer to	Code
How often do you follow principle X in your hospital?	
Rarely (0–25%)	1
Sometimes (26–50%)	2
Most often (51–75%)	3
Always (76–100%)	4
Was your practice the same in 2017?	
Do not know	1
No, did it more often in 2017	2
Yes (no change in practice)	3
No, did it less often in 2017	4

For full survey, including the list and description of the 25 ERAS[®] principles, see **Error! Reference source not found.**

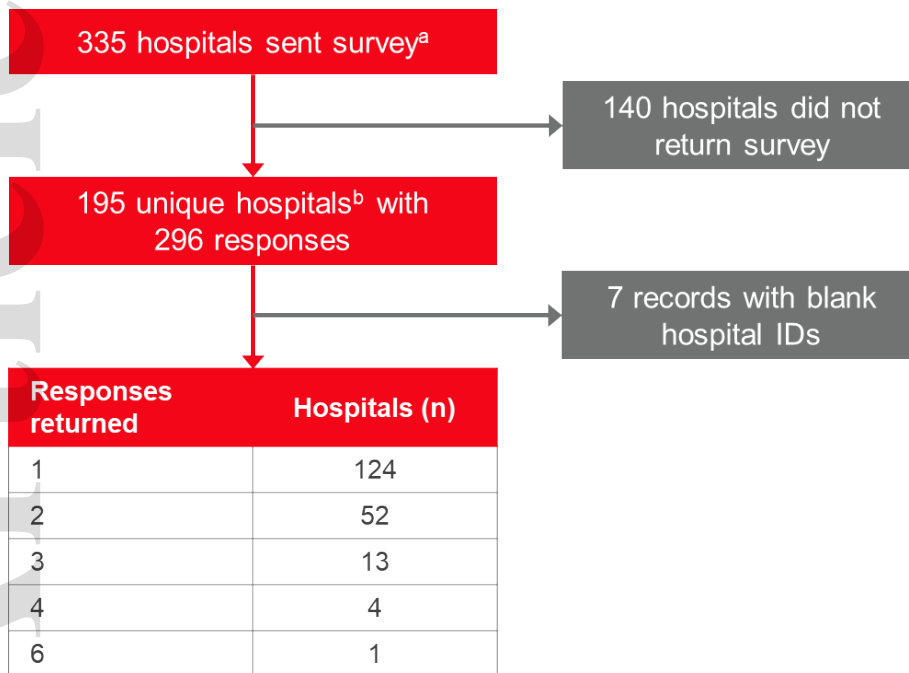
Abbreviation: ERAS[®]: Enhanced Recovery After Surgery.

Table 2. Hospital characteristics

Hospital characteristics	Overall (N ^a =186), N (%)
Hospital type	
District general hospital	50 (26.9%)
University hospital or tertiary centre	136 (73.1%)
Region^b	
Southern Europe	75 (40.3%)
Northern Europe	46 (24.7%)
Western Europe	22 (11.8%)
Eastern Europe	20 (10.8%)
Western Asia	12 (6.5%)
Eastern Asia	2 (1.1%)
South-Eastern Asia	2 (1.1%)
Northern Africa	2 (1.1%)
South America	2 (1.1%)
Australia and New Zealand	1 (0.5%)
Northern America	1 (0.5%)
Southern Asia	1 (0.5%)
World Bank income status^c	
High	152 (81.7%)
Upper-middle	30 (16.1%)
Lower-middle	4 (2.2%)
Number of beds^d	
≥1,000	40 (21.6%)
650–<1,000	51 (27.6%)
400–<650	46 (24.9%)
<400	48 (25.9%)

^aExcludes the nine hospitals missing identification. ^bDefined by the Geographic Regions of the United Nations (M49 Standard) [23]. ^cDefined by the World Bank income status [24]. ^dMissing data from one hospital and percentages calculated out of 185 hospitals.

Figure 1. Hospital responses



^aThe 2017 ESCP collaborating group; ^bIncludes nine unique but missing hospitals (Missing Hospital 1 through Missing Hospital 9) and seven records with blank hospital IDs.

Abbreviations: **CONSORT:** Consolidated Standards of Reporting Trials; **ESCP:** European Society of Coloproctology; **IDs:** identifications.

Figure 2. Uptake of ERAS® principles in 2019/20

Figure 2A

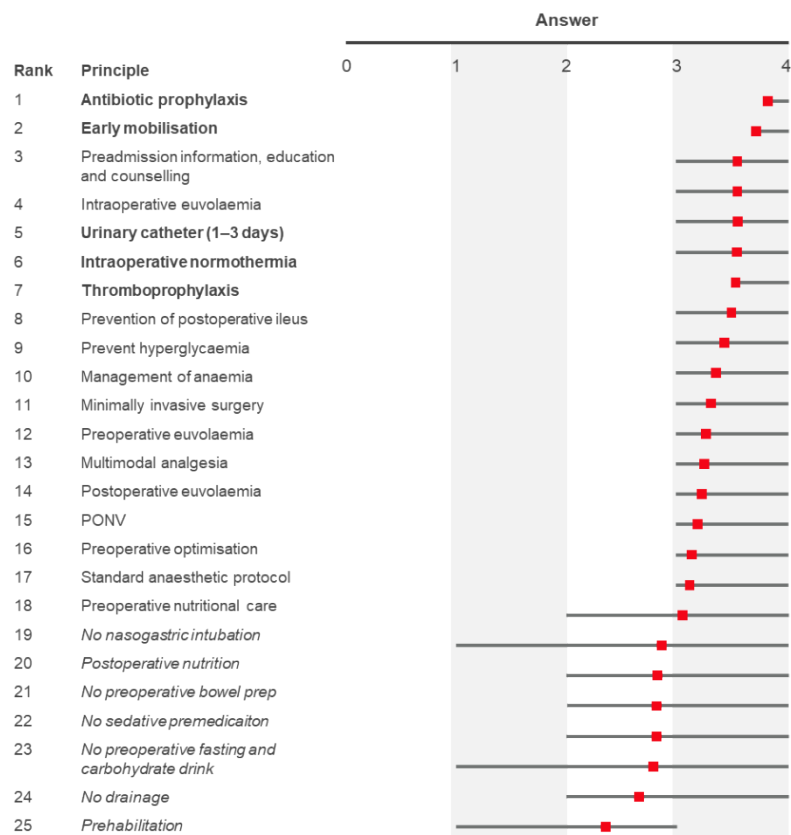


Figure 2B

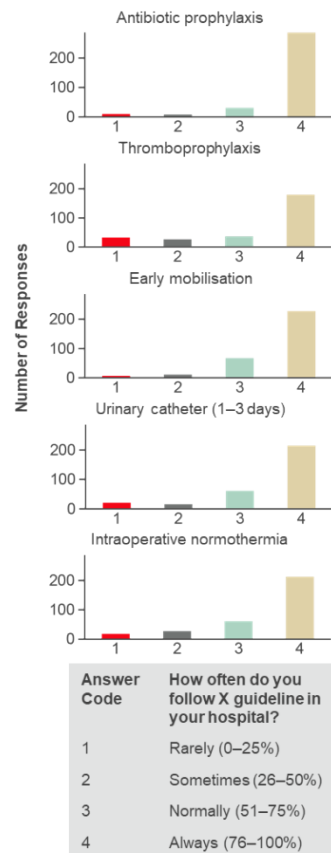
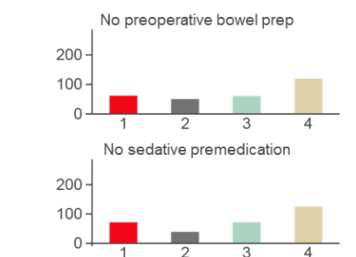
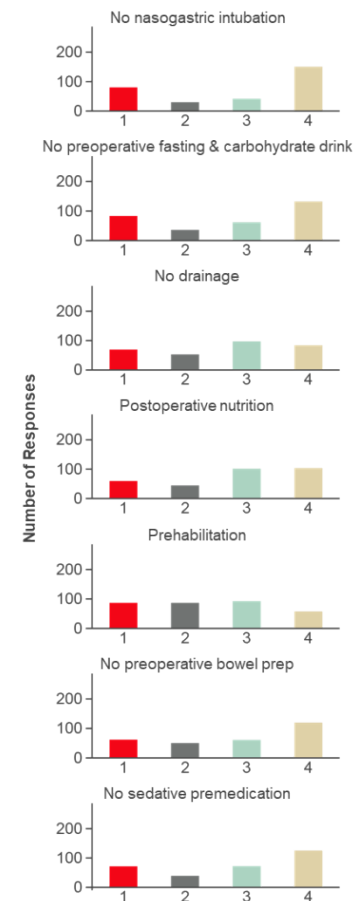


Figure 2C



Answer Code	How often do you follow X guideline in your hospital?
1	Rarely (0–25%)
2	Sometimes (26–50%)
3	Normally (51–75%)
4	Always (76–100%)

(A) ERAS[®] principles ranked by mean uptake; squares indicate mean uptake; bars indicate variability across answers, as assessed by IQR. (B) Highlighted principles where the highest proportion of respondents answered 'always'; bolded in panel A. (C) Highlighted principles where with the highest variability of uptake across centres where the mean score is <3; italicised in panel A.

Abbreviation: ERAS[®]: Enhanced Recovery After Surgery; **IQR:** interquartile range.