


# BMJ Open Quality Development and implementation of a quick reference (QR) code linked online education tool in anaesthesiology practice

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## ABSTRACT

**Background** We conducted a feasibility study of an anaesthetic online educational tool that is accessed via quick reference (QR) codes. The primary objective of the study was to assess the feasibility of an online educational tool for providing satisfactory teaching to patients presenting for surgery and assess if using QR codes are a viable method for directing patients to the information. The secondary objective was to obtain feedback from anaesthesiologists.

**Methods** The educational tool was developed and hosted on a password-protected website. The educational material on the website focused on anaesthesia-related processes that the patient should expect to experience in the hospital as well as fasting information. A survey was embedded into the website to obtain patient feedback. The website was redesigned following patient and staff feedback.

**Results** Ninety-three patients accessed the online education tool. Of the 73 responses to the survey, 81% of patients reported that the tool improved their knowledge and understanding about anaesthesia. 73% of patients expressed a preference for, or were neutral regarding using online patient education. 36% of patients were familiar with QR codes and 28% were frequent users of QR codes. Most anaesthesiologists expressed satisfaction with the tool being used by their patients following the redesign process (93.1%, 89.6% and 89.6% for general anaesthesia, neuraxial anaesthesia and regional anaesthesia, respectively).

**Conclusions** This feasibility study demonstrated that an online anaesthetic educational tool has utility in promoting patient education about the anaesthetic experience and was well received by both patients and anaesthesiologists. QR codes are not feasible as the sole method for linking our patient population to an online education resource.

## INTRODUCTION

For many patients coming for surgery, there is unsurprisingly significant anxiety around anaesthesia.<sup>1 2</sup> International anaesthetic guidelines recommend that educational information is provided to patients as soon as possible prior to surgery.<sup>3 4</sup> Purpose-built online education tools have been shown to decrease patient anxiety before invasive

## WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Health-related internet usage is increasingly common. Providing patients with sufficient educational materials in a timely fashion is considered gold standard practice in anaesthesia. We wanted to test the design of a preoperative education website to check that it was functional and useful for our patient population and staff. We also wanted to assess if quick reference (QR) codes would be a practical way of linking our patients to the online educational resource.

## WHAT THIS STUDY ADDS

⇒ If given the opportunity, most patients will choose to access education material provided to them online. Patients reported that it increased their knowledge of anaesthesia, and it had no negative impact on the workload of anaesthesiologists in the preoperative clinic. QR codes were not a sole feasible method for distributing online information to our patient population.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The online education tool for anaesthesia was welcomed by the majority of patients. Nearly all anaesthesiologists who reviewed the website wanted to continue using the online patients education tool in their practice.

procedures and increase their knowledge prior to the procedures.<sup>5 6</sup> Delivering patient education material online allows it to be shared with family members and caregivers and accessed multiple times.

Internet access in Canada is nearly universal: 94% of Canadians have access to broadband internet at home. In 2020, the proportion of older Canadians who have access to the internet at home has increased to 83%. An additional 1.5% of Canadians have access to the internet via their mobile data plan.<sup>7</sup>

Health-related internet usage is common. It is consistently more prevalent in younger



people, those with higher levels of educational attainment and those with high levels of English literacy.<sup>8–10</sup> In a 2017 US study of arthroplasty patients, 62% of patients accessed the internet for health-related information.<sup>11</sup> In one cohort study, 66% of patients presenting for lumbar spine surgery had used the internet to seek information specific to their upcoming surgery.<sup>10</sup> At the same time, quick reference (QR) codes are also becoming increasingly used to allow patients to easily access online education tools.<sup>5 12</sup>

As the internet is a frequent resource for patients seeking health information, there is an onus on clinicians to ensure that the material available to their patients is accurate and accessible. There is a substantial amount of health misinformation available online.<sup>13</sup> The reading level of online patient education material for anaesthesia was found to consistently require reading proficiency at or above the 13th US grade level.<sup>14</sup> The American Medical Association recommends education material be delivered at the 6th US grade level.<sup>14</sup> While online patient education tools may not change traditional outcomes in a surgical population,<sup>15</sup> it would be remiss to ignore one of our patients primary methods of health information gathering.

Anaesthesiologists based at Vancouver General Hospital (VGH) staff the preanaesthetic clinic, which review those patients who are identified as having complex medical issues or those who require major surgery at VGH or the University of British Columbia Hospital (UBCH). VGH is a tertiary referral hospital for the province of British Columbia, with a full complement of adult contemporary surgical services, while UBCH primarily cares for patients needing outpatient elective surgery. Between VGH and UBCH, 14000 elective surgeries are done per annum. Excluding anaesthesia for dental procedures (median age 25 years old), our patients's median age ranges, depending on surgical speciality, from 49 year of age (plastic surgery) to 76 years of age (interventional cardiology).<sup>16</sup> Between 35 and 44 patients are reviewed by staff anaesthesiologists per weekday, while another 35 to 40 patients are reviewed by nursing staff alone. There is an increasing proportion of patients who are unable to be seen in the preanaesthetic clinic prior to their elective surgery due to no appointments being available. During the COVID-19 pandemic, the preanaesthetic clinic moved to almost entirely telephone and Zoom-based consult service, making the online delivery of education material more practical than traditional paper-based methods.

In an era of increasing internet and smartphone use, we identified that an online anaesthesia education resource could decrease barriers for patients to access timely and accurate information during the perioperative journey. It also could decrease repetitive workload for the anaesthesiologists in the preanaesthetic clinic. As patients receive multiple sources of information, it is not possible for a single clinician to provide a detailed picture of the entire anaesthetic experience or to give an unhurried account of fasting instructions. We aimed for the online education

tool to supplement the existing methods of in-person patient education, rather than replace them. We aimed to develop an online education tool that was usable and acceptable to patients and staff.

## METHODS

While many excellent online anaesthesia education tools exist for patient information, none accurately described the expected patient experience at Vancouver Coastal Health (VCH). To avoid confusion, it was decided that it would be useful to build our own educational tool that contained information specific to the care they would receive at our institution. For example, it is common for patients having open abdominal procedures at our institution to receive a thoracic epidural for postoperative analgesia. We determined that our primary feasibility measures for the online tool were: (1) if over 70% of patients surveyed responded that they agreed or strongly agreed that the online tool increased their knowledge of anaesthesia and (2) if over 70% of patients responding that they agreed or strongly agreed that they were familiar with using QR codes. Our secondary measure was the acceptability of the online education tool to the VCH anaesthesiologists. We decided to collect data from a single calendar week in the preanaesthetic clinic.

### Design of the website

The website was built by one of the authors (MD) using the commercial website building platform Wix.com. The website ([www.vancouveranesthesiainfo.com](http://www.vancouveranesthesiainfo.com)) contained pages on general anaesthesia, general anaesthesia with planned postoperative intensive care stay, spinal anaesthesia, epidural anaesthesia and regional anaesthesia. It also contained a page about fasting instructions prior to anaesthesia and appropriate types of clear fluids while fasting. The website consisted of text and stock photo images of anaesthesia (see example in online supplemental file 1). The written text was simplified as much as possible, and the final text used was analysed for its readability using the online tool Readable.<sup>17</sup> When complex words were identified, they were simplified when a synonym was available. All pages had a Flesch Kincaid Grade Level of less than US year 8. No videos were used in the creation of the website.

The opinions of multiple senior members of the anaesthetic department were sought on an adhoc basis regarding the content of the website. The educational material on the website focused on the process that the patient should expect to experience in the hospital as well as fasting information. It was decided that in its preliminary format, the website should not contain specific information regarding the risks of different anaesthetic techniques. The website was designed to be legible and functional across multiple browsers and when viewed from a smartphone. Accessibility was assessed using the Lighthouse developer tool on Google Chrome. All pages scored 100%.

The website was designed to prompt patients, at the end of reviewing the information, to complete the survey. To reduce uninvited traffic, the home page of the website was initially password protected and the website pages were unindexed.

Descriptive statistics were used to analyse the patient and anaesthesiologist data. Thematic analysis of the free text comments was done using a semantic inductive approach using the coding software Taguette (V.1.3.0). Coding of data was done by two of the authors (MD and YTL) independently.<sup>18</sup>

### Patient and public involvement

Patients or the public were not involved in the initial design or reporting of our feasibility study. Patients were introduced to the feasibility study via an email that explicitly stated that their participation in reviewing the online education tool was voluntary, anonymous and would not alter their usual care in hospital. Patient feedback prompted the website redesign. The time burden involved in viewing the online educational tool was assessed using the website traffic data.

### Questionnaire design

No identifying information was collected from patients in the survey. Questionnaires, using a Likert scale (1—‘strongly disagree’, to 5—‘strongly agree’), were prepared and completed by patients and anaesthesiologists respectively (boxes 1 and 2). The patient questionnaire was built into the website, and the anaesthesiologist questionnaire was delivered in hardcopy. A free text comment area at the end of each survey was available if patients or staff had suggestions. A Likert scale Questionnaire was again used to survey anaesthesiologists following the website redesign.

### Patient survey

All patients who had an email address available in their hospital chart between 72 and 24 hours prior to their preoperative clinic appointment with an anaesthesiologist between 28 February and 4 March 2022 were identified. Patients were individually emailed on their nominated email address. The educational role of the preoperative website was introduced in an email. They were requested to view information relevant to the most likely type of anaesthetic they would receive, as chosen by an experienced anaesthetic provider (MD). They were provided with both web links and QR codes that directed them to information about the type of anaesthesia they were likely to receive and fasting information. The website requested patients complete a short online questionnaire after viewing the material. Patients who were likely to receive monitored anaesthetic care (sedation only), those who had a translator booked for their anaesthetic clinic appointment and those who did not have a valid email address available in their preoperative questionnaire were not contacted.

### Box 1 Patient questionnaire

Q1. My age is:

Q2. My gender is: male/female/non-binary/prefer not to say (select one)

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Q3. I am familiar with quick reference (QR) codes?

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Q4. I have used QR codes previously in my daily activities?

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Q5. I prefer to have access to educational information by mobile technology.

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Q6. The online education material helped me to better understand the anaesthetic?

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Q7. The online education material increased my knowledge about the anaesthetic?

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Q8. I would like to use QR codes and online education material in future activities, connected with anaesthesia?

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Q9. Do you have any other comments on how to make this website more useful for future patients?

While the preanaesthetic clinic is almost entirely done as a telephone or Zoom service at the time of writing due to the COVID-19 pandemic, we are moving back to seeing

## Box 2 Anaesthesiologist questionnaire

Q1. I am familiar with quick reference (QR) codes?

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Q2. I have used QR codes previously in my practice?

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Q3. I prefer to have access to educational information by mobile technology?

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Q4. The use of the online education material in my practice met my expectations?

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Q5. The use of the online education tool provides more opportunities for higher level work in the preoperative anaesthetic clinic?

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

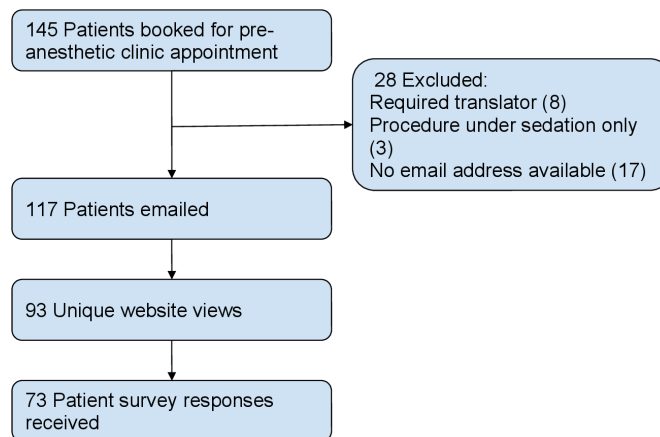
Q6. The use of the online education resource helped me to give my patient necessary information for their upcoming procedure?

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Q7. I would like to continue using the online education tool in my future practice?

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

Q8. Do you have any other comments?



**Figure 1** Patient flow diagram.

## Anaesthesiologist survey

An opportunistic survey of the anaesthesiologists working in the preoperative clinic during the same period was completed. All were introduced to the website and its role by the lead author. Each anaesthesiologist who was working in the preanaesthetic clinic during the week the patient education resource was distributed was asked to complete the survey once. The surveys were anonymous.

## RESULTS

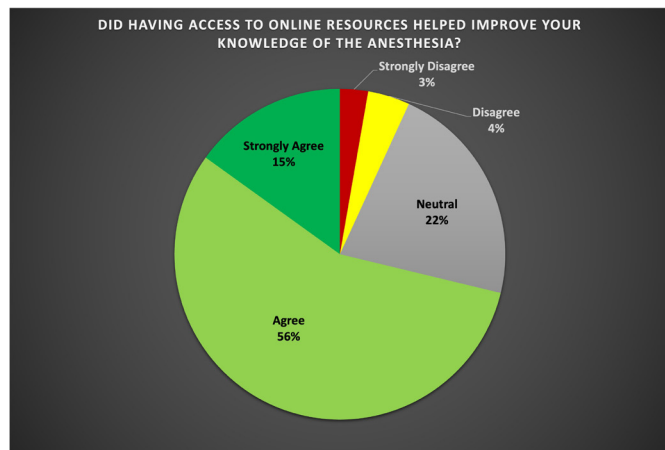
### Patient survey

Overall, 145 patient charts were available to be reviewed. Of those, 28 patients were excluded; due to requiring a translator (8 patients), booked for a procedure under sedation only (3 patients) or no email address available (17 patients). Overall, 117 individual patients were emailed and requested to review the website. Based on the website traffic data over the period that the survey was released, there were 93 unique visitors (79% of those patients contacted). There were 73 responses to the survey (62% of those contacted) (see [figure 1](#)). Patients spent an average of 8 minutes viewing the website. The mean age of survey participants was 66 years and the median age was 69 years of age. All the patients surveyed were between 35 and 95 years.

The majority (71%) of patients agreed or strongly agreed that the online education material improved their knowledge regarding anaesthesia ([figure 2](#)). Most (81%) of patients who completed the survey stated that the online resource helped them to better understand their anaesthetic. Approximately half of patients (48%) agreed or strongly agreed they had a preference for receiving educational information online, while 25% were neutral and 18% disagreed or strongly disagreed.

The majority of patients who responded to the survey were unfamiliar with QR codes. Overall, 35.6% of patients agreed or strongly agreed that they were familiar with the use of QR codes ([figure 3](#)). Only 28% of patients who responded stated that they agreed or strongly agreed that they frequently used QR codes.

patients in person, and as such the decision was made to include questions regarding the acceptability of using QR codes to access information.



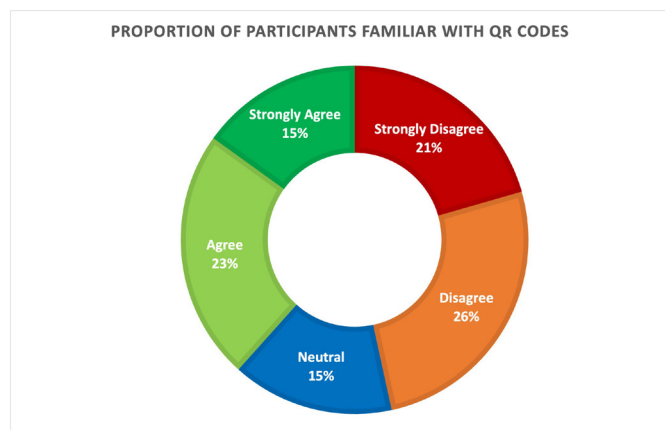
**Figure 2** Effect of online education tool on patient knowledge of anaesthesia.

### Thematic analysis of comments from patients

A thematic analysis of the 24 free text comments was independently conducted by two authors (MD and YTL). The major themes (over five occurrences) identified by both authors were: patients found the website contains information that was useful to them, respondents wanted more detailed information specific to the potential side effects of anaesthesia from the website and that QR codes were unfamiliar to the patients.

### Anaesthesiologist survey

Of the 10 Anaesthesiologists surveyed, 9 were familiar with QR codes and all 10 expressed a preference for the continued use of the online tool for preanaesthetic patient education. A majority (80%) felt that the online education tool provided more opportunities for higher level work in the preanaesthetic clinic. Half of the anaesthesiologists felt that the online educational tool helped them to provide patients with the necessary preoperative education and all expressed a desire to have access to the online educational tool via a mobile platform.



**Figure 3** Patient familiarity with quick reference (QR) codes.

### Repeated anaesthesiologist survey following revision of the website

The development of the online education tool has been an iterative process, taking feedback from patient comments and anaesthetic staff. A page discussing monitored anaesthetic care has been added. Following the feedback from the patient survey that patients wanted more specific information regarding the side effects of anaesthesia, the website was rewritten to include this. A balanced approach was taken, highlighting the benefits of different anaesthetic techniques as well as the risks. Real-world equivalent risks were used to help patients conceptualise rare but significant risks such as nerve damage in neuraxial procedures according to best practice recommendations.<sup>19 20</sup> This approach reflects the shared decision-making process advocated for by the Royal College of Physicians and Surgeons of Canada, the Canadian Medical Protective Association and the Canadian Medical Association.<sup>21-23</sup> The results from the patient survey were presented to the VCH anaesthesia department grand rounds meeting on the 1 June 2022. After outlining the project, the staff anaesthesiologists were surveyed. There were 29 responses to the second anaesthesiologist survey from 72 current staff members of the department. The vast majority of staff anaesthesiologists agreed or strongly agreed with the education material being shown to their patients for general anaesthesia, neuraxial anaesthesia and regional anaesthesia (93.1%, 89.6% and 89.6%, respectively). Detailed results of this survey are contained in online supplemental file 2.

### DISCUSSION

The feasibility study demonstrated that the online education tool met our first measure. While most patients preferred having access to online education material, it is important to note that 18% of participants did not prefer the online format. For this patient group, our standard educational tools of preoperative phone calls from nursing and medical staff are their primary educational opportunities before they arrive in the OR. The online preoperative education tool serves the significant proportion of patients who will access the internet for health-related information. If institutions do not supply patients with online education material, it is likely that the majority of patients will access it themselves from other sources. This may lead to patients reading information that is not relevant or inaccurate.<sup>13</sup>

Our feasibility study has also demonstrated that there is limited knowledge of QR codes in our patient population that attends the preanaesthetic clinic. While it is likely that the proportion of patients who are familiar with this technology continues to increase with time and commercial adoption, it is not currently a feasible primary method for information distribution to our patient population.

Lack of English language proficiency should not be a barrier to receiving educational information preoperatively. In British Columbia, data shows that one quarter of

patients speak a language other than English as their first language.<sup>24</sup> As the website is in its infancy, it is currently written in English only. Members of VCH anaesthesia department reflect the broader community and there are plans to have the website translated into the three most common languages spoken in British Columbia after English. Additional accessibility improvements could be made by making the online preoperative educational material available in video format. This may decrease the barriers for accessing accurate material for a subset of patients.<sup>8</sup>

A pop-up disclaimer has been added to the website following the redesign process to alert patients that their final care plan will be made in conjunction with their treating anaesthesiologist on the day of surgery. This was to allay concerns that some staff anaesthesiologists had about the need to tailor shared decision-making discussions to the health needs of particular patients.

### Limitations

Due to the time burden of one practitioner manually sending the emails after reviewing individual patient charts, the online education tool was only distributed to those patients who were booked for the preanaesthetic clinic. This group of patients already has the opportunity to have a discussion with an anaesthesiologist prior to their presentation to the hospital. It is likely that the group that would benefit the most from the online preoperative education material are those patients who do not have a preanaesthetic clinic appointment. This limits the generalisability of our results and highlighted the need to automate the process for delivery of the online education tool. The results of this study, along with other successful projects to modernise the preadmission clinic have resulted in funding and IT support allocated for this transition.

Our institution has developed a system that allows patients to submit their preoperative health questionnaire online and nominate a preferred email address. Registered nurses working in the preanaesthetic clinic will email patients URL links to the online educational material relevant to their procedure, guided by routine practices in our institution. QR codes will be available for those patients attending in person who prefer to use them. We plan to fully automate linking the online patient health questionnaire to the online educational material in the future. The patient survey will be repeated following these process changes, allowing assessment of the usefulness and functionality of the new content on the website and new distribution process. The preoperative education website is planned to be routinely used as part of the pre-anaesthetic clinic process from 2023.

As this was a voluntary survey to assess the functionality and usefulness of a new online education tool, the feasibility study suffers from both sampling and responder bias. Those patients who did not have an email address recorded had no opportunity to view the educational information. It is likely that those patients who reviewed

the website and filled in the survey were interested in receiving more information regarding anaesthesia. Despite this, the majority of the patients who reviewed the online education tool and completed the survey saw value in reviewing the material.

### CONCLUSIONS

Patients increasingly seek health information online. This feasibility study showed that the anaesthesia online education tool was well received by patients and staff. Most patients will view online educational information if it is provided to them and the majority found that it increased their knowledge of anaesthesia. QR codes are not currently feasible as the sole method of delivering patient educational information at our institution, as our patient population is not familiar with them.

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**Contributors** MD wrote the manuscript, developed the initial concept, created the online preoperative education tool, collected the data, did the thematic analysis and is the guarantor. YTL assisted with data collection, analysed the data (descriptive statistics and thematic analysis) and made the figures. DJY provided invaluable assistance in his role as co-lead for the preanaesthetic clinic, assisted with ideas for the online education tool and assisted with drafting the manuscript. HV helped conceived the idea, assisted in the draft of the manuscript and contributed to editing the online tool.

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**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

**Patient consent for publication** Not applicable.

**Ethics approval** This project was exempt from requiring University of British Columbia's research ethics board review as it was within the scope of the Vancouver Coastal Health quality improvement guidelines and consistent with the preanaesthetic assessment clinic's aim to move patient information online.

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**Data availability statement** All data relevant to the study are included in the article or uploaded as online supplemental information.

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