Carbon dioxide for gut distension during digestive endoscopy: Technique and practice survey

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Abstract

Aim: To assess the adoption of Carbon dioxide (CO₂) insufflation by endoscopists from various European countries, and its determinants.

Methods: A survey was distributed to 580 endoscopists attending a live course on digestive endoscopy.

Results: The response rate was 24.5%. Fewer than half the respondents (66/142, 46.5%) were aware of the fact that room air can be replaced by CO₂ for gut distension during endoscopy, and 4.2% of respondents were actually using CO₂ as the insufflation agent. Endoscopists aware of the possibility of CO₂ insufflation mentioned technical difficulties in implementing the system and the absence of significant advantages of CO₂ in comparison with room air as barriers to adoption in daily practice (84% and 49% of answers, respectively; two answers were permitted for this item).

Conclusion: Based on this survey, adoption of CO₂ insufflation during endoscopy seems to remain relatively exceptional. A majority of endoscopists were not aware of this possibility, while others were not aware of recent technical developments that facilitate CO₂ implementation in an endoscopy suite.
(e.g. gas tension gradient between the intestinal lumen and blood) or identical for all digestive gases (e.g. surface and thickness of the exchange membrane, and tissue perfusion)\(^1\)\(^2\).

Despite the high level of evidence supporting the use of CO\(_2\) for gut distension during colonoscopy and other endoscopic procedures, this gas does not seem to be used in many endoscopy practices. We here report a survey that was performed in a large group of endoscopists to assess the use of CO\(_2\) insufflation in daily endoscopy practice, including reasons for possible non-adoption.

**MATERIALS AND METHODS**

**Survey design and administration**

A questionnaire was developed by the authors for the study. Content validity of the survey was determined based on input by experts in the field and a review of the relevant literature. The final, two-page, 26-item, survey contained two parts: the first one addressed respondents’ demographic characteristics and knowledge about the use of CO\(_2\) as room air replacement during gastrointestinal endoscopy; and the second part was divided into two sections directed to endoscopists who, either did (“practitioners”), or did not (“non-practitioners”) use CO\(_2\). Non-practitioners were asked for which reasons they did not use CO\(_2\), while practitioners were asked about their actual use of CO\(_2\).

The survey was performed during the 26th European Workshop on Gastroenterology and Endotherapy held in Brussels, Belgium, on 16-18 June 2008. Questionnaires were placed in cases distributed to course participants, and attendees were asked to deposit completed surveys in a dedicated box at the registration desk. Consent to participate in this study was inferred from voluntary completion of the survey. Efforts to increase response rates included two rehearsals by the course director (Deviere J), projection of a reminder slide during breaks, and collection of surveys by staff members who passed between rows of participants or were posted at the exits of the projection rooms. No gift or financial incentive was proposed to attendees.

**Statistical analysis**

Results are expressed as mean ± SD or as a percentage. Each response was included in the analysis, regardless of the completeness of the survey. In cases when not all survey respondents answered to an individual question, the number of respondents (i.e. the denominator for percentage calculations) is indicated.

**RESULTS**

**Study population**

Surveys were distributed to 580 medical doctors attending the course, and 142 of them completed the study (response rate, 24.5%). All of them answered all the demographic questions (Table 1). The respondents had their endoscopy practice in 21 countries, but six of these (Belgium, Greece, Italy, France, Spain and Switzerland) made up two-thirds of the respondents. Main practices were roughly equally distributed between private practice, community hospitals and university hospitals. Sedation with propofol or general anesthesia was used for more than 50% of colonoscopies by about half the respondents.

**Answers to the survey**

Fewer than half of the respondents (66/142, 46.5%) were aware that room air could be replaced by CO\(_2\) for gut distension during endoscopy. Thirty-eight respondents (26.8%) had previously seen (n = 24) or performed (n = 14) an endoscopy procedure using CO\(_2\), with only six of them actually practicing this technique (adoption rate of the technique in the whole population, 4.2%). Fifty-eight (87.9%) of the 66 respondents who were aware of the technique also stated that all RCTs had shown that CO\(_2\) insufflation decreased pain and gut distension compared to air insufflation. The proportions of survey respondents who correctly answered questions relating to various aspects of CO\(_2\) use during endoscopy are shown in Figure 1.

One hundred and thirty endoscopists answered why they did not use CO\(_2\): 73 (56.1%) of them were not aware of this possibility, and those who were aware most often cited “technical difficulties in implementing the

|Characteristics                                      | n (%)         |
|-----------------------------------------------------|---------------|
|Male gender                                          | 109 (76.8)    |
|Age (yr)                                             | 47.7 ± 9.1    |
|Years in practice                                    | 17.5 ± 9.2    |
|Country                                              |               |
|Belgium                                              | 25 (17.6)     |
|Greece                                               | 18 (12.7)     |
|Italy                                                | 18 (12.7)     |
|France                                               | 16 (11.3)     |
|Spain                                                | 10 (7.0)      |
|Switzerland                                          | 9 (6.3)       |
|Other                                                | 46 (32.4)     |
|Main practice setting                                |               |
|Private                                              | 36 (25.4)     |
|Community Hospital                                   | 54 (38.0)     |
|University Hospital                                  | 52 (36.6)     |
|No. of colonoscopies performed/year in the center    |               |
|< 500                                                | 7 (4.9)       |
|500-1000                                             | 40 (28.2)     |
|1000-1500                                            | 33 (23.2)     |
|> 1500                                               | 62 (43.7)     |
|Proportion of colonoscopies performed with propofol/general anesthesia | |
endoscopists were not aware at all of the possible use of CO₂ during endoscopy, while the remainder ignored recent practical developments (they cited technical difficulties in implementing CO₂ as the main factor limiting its adoption, even though CO₂ insufflators have become more widely available). The other major reason cited for not adopting CO₂ was that advantages for the patients were not sufficiently significant. This likely relates to a lack of information among endoscopists about post-colonoscopy patient inconvenience (only one-third of them knew that 20% of patients need ≥ 2 d before being able to return to their normal activities after screening colonoscopy)\(^{{[16]}}\).

Endoscopists currently pay more attention to patients' comfort; for example, polyethylene glycol is being replaced by sodium phosphate for bowel preparation before colonoscopy\(^{{[17]}}\). However, recent reports have shown that phosphate nephropathy may complicate bowel preparation using sodium phosphate, even after a single preparation\(^{{[18]}}\). Another example is the use of propofol for sedation in replacement of benzodiazepines\(^{{[19]}}\). CO₂ deals with the post-procedure phase of colonoscopy by reducing bloating and abdominal pain, the most frequent side effects of colonoscopy\(^{{[16]}}\). However, it remains to be demonstrated if the advantages conferred by CO₂ are sufficiently significant to improve patient acceptance of endoscopic procedures and cost-effectiveness (by reducing loss from normal activities after endoscopy). These two criteria, namely patient acceptance and cost-effectiveness, are of paramount importance for colorectal cancer screening as computed tomography (CT) colonography has been shown to be superior to colonoscopy for both of them\(^{{[20,21]}}\). Incidentally, one of the three CO₂ insufflators that are available for endoscopy was developed initially for gut distension during CT colonography, and radiologists use it increasingly often for reasons of safety and patient comfort (CO₂ is used in about half of CT colonographies)\(^{{[22]}}\). In our survey, the use of CO₂ for CT colonography was not perceived by endoscopists as an incentive to change their practice. As endoscopists become aware of the ease and benefits of CO₂ implementation in an endoscopy suite, the use of CO₂ may be the next logical step to minimize patient discomfort.

Most endoscopists reported that a demonstration (in their endoscopy unit or in a workshop) was likely to change their perception of CO₂ usefulness. This corroborates our previous observation that endoscopists' opinion may significantly change following a demonstration of a particular endoscopic technique\(^{{[23]}}\). However, it remains to be seen if intentions translate into actual changes, in particular, because CO₂ benefits are mainly observed after sedation reversal, when many patients are not evaluated by endoscopists.

From a practical standpoint, CO₂ is readily available in centers where laparoscopic surgery is performed (or it can be purchased from various distributors), and endoscopic CO₂ insufflators have recently become more

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**DISCUSSION**

CO₂ was used for gut distension during endoscopy by < 5% of survey respondents, even though all RCTs performed since the description of the technique 35 years ago have shown that pain is lower with CO₂ compared to air\(^{{[2,3,4,5,14]}}\). Indeed, the adoption rate found in the present study was even lower than that reported 20 years ago in a survey of US hospitals in Illinois (13% for colonoscopy)\(^{{[18]}}\). A majority of endoscopists

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**Figure 1** Percentages of correct answers (yes/no choice; correct answer was yes in all cases) to the following questions. CO₂ insufflation is not advised in patients with severe pulmonary diseases; "About 20% of patients still have pain 6 h after colonoscopy using air insufflation; "About 20% of patients need ≥ 2 d before they are able to return to their normal activities after screening colonoscopy; "Compared to air, CO₂ colonoscopy decreases the risk of bowel explosion; "Compared to air, CO₂ insufflation is better for ERCP and double balloon enteroscopy DBE.
widely available (Table 2). CO₂ insufflators are electrically powered devices that combine at the minimum a gas pressure regulator, a safety pressure valve to protect against over-insufflation, and connection tubes. When CO₂ is used, the regular air insufflation is inactivated (to prevent endoscopic insufflation with both gases), and endoscope manipulation is unchanged compared to using air for gut distension (CO₂ insufflation is obtained by placing the finger on the vent hole of the insufflation/irrigation valve, and lens cleaning is obtained by firmly pressing this valve). One may also switch from one gas to another during an endoscopic procedure. Contraindications to the use of CO₂ are limited to severe chronic obstructive pulmonary disease (if CO₂ is absorbed at a rate exceeding its respiratory elimination, this leads to CO₂ retention and pulmonary acidosis) [2,3]. Provided that this contraindication is observed, Bretthauer et al [3] have shown that, although pCO₂ levels increase during colonoscopy and ERCP (due to the effect of sedative drugs), this increase is no more important with CO₂ than with air insufflation [4,5].

Finally, the cost of an insufflator was cited as a limiting factor by endoscopists who attempted to implement the system. The cost of an insufflator ranges between 7000 and 7400 euros. The cost of CO₂ gas per colonoscopy is < 1 euro (renting a 2400-L CO₂ tank costs about 50 euros/year, and refilling it costs 25 euros; this volume is sufficient for 800 min of continuous insufflation; a mean of 8.3 L is used per colonoscopy procedure) [5]. The acquisition cost should be viewed in light of the multiple uses of these systems (e.g. colonoscopy, ERCP, double balloon enteroscopy) and ideally, from a societal perspective. Indeed, if cost calculations of screening colonoscopy took into account total time lost from work for patients undergoing the examination, as well as for the person accompanying the patient, this would increase the cost by about 50% [6]. A catalyst for CO₂ adoption by endoscopists could be the implementation of CO₂ insufflation capabilities into standard endoscopy processors, as additional costs would be hard to justify in the absence of specific reimbursement. The endoscope manufacturer that would first take this step would have a competitive advantage.

Our study has several potential limitations, including selection bias and the relatively limited number of responders. However, survey respondents were distributed relatively evenly between different endoscopy practices, and an international audit with a larger panel of individual respondents than reported here is notably difficult to organize [27,28].

In conclusion, the use of CO₂ for gut distension during endoscopy remains exceptional despite the results of numerous RCTs that have shown the superiority of this technique compared to air. A majority of endoscopists are unaware of this possibility, while those who are aware mostly think that CO₂ implementation in an endoscopy suite is technically difficult or presents few advantages. Greater availability of CO₂ insufflators, more widespread use of CO₂ in competing CT colonography, and better endoscopists’ education have the potential to change this situation.

### COMMENTS

#### Background
Carbon dioxide (CO₂) is cleared much more rapidly than air from the bowel and randomized controlled trials have consistently shown that it is superior to air for several gastrointestinal endoscopy procedures. In particular, advantages were demonstrated for colonoscopy (less pain), endoscopic retrograde cholangio-

#### Research frontiers
Use of CO₂ is common for colon computed tomography but it does not seem to be widespread in endoscopy practice. Reasons for possible non-adoption of this gas are unknown.

#### Innovations and breakthroughs
No data about the use of CO₂ by endoscopists have been available for > 20 years. Recently, CO₂ insufflators for endoscopy have become commercially available.

#### Applications
As a majority of endoscopists were not aware of the possibility to use CO₂ as air replacement during endoscopy, specific endoscopists’ education and implementation of CO₂ insufflation capabilities into standard endoscopy processors should be encouraged.

#### Peer review
The cost of equipment required for CO₂ insufflation during endoscopy is the main barrier to adoption of this technique; it is actually around 7000 euros.
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