Endoscopic perforation rates at a Canadian university teaching hospital

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BACKGROUND: Despite advances in training, operative techniques and endoscopic technology, upper and lower endoscopic procedures continue to have potential for intestinal perforation. Perforation rates provided to patients at the time of consent have frequently been derived from historical cohorts and survey datasets.

OBJECTIVE: This study examined the perforation rates of upper and lower endoscopic procedures at a major Canadian tertiary care centre.

METHODS: Inpatient and outpatient gastroscopies and colonoscopies performed during a three year period were evaluated. Endoscopies with perforations occurring within 14 days of procedure were retrospectively isolated using the International Classification of Diseases – 9th Revision code descriptions, then retrieved and hand searched to confirm a procedure-related perforation. Data were extracted to identify risk factors and patient outcomes.

RESULTS: A total of 21,217 endoscopies (13,792 gastroscopies and 7425 colonoscopies) were reviewed. Of these, 359 were identified, isolated and hand searched for confirmation of a perforation event. Eighteen were found to have an endoscopy-associated perforation. Ten perforations occurred with gastroscopy (0.06%) (incidence: 0.6/1000 procedures), resulting in zero mortality. Of gastroscopy procedures the rate of perforation with diagnostic gastroscopy was 0.13% (incidence: 1.3/1000 procedures), resulting in one death (0.013%) (incidence: 0.13/1000 procedures). Eight perforations occurred with gastroscopy (0.06%) (incidence: 0.6/1000 procedures), resulting in zero mortality. Of colonoscopy procedures the rate of perforation with diagnostic colonoscopy was 0.13% (incidence: 1.3/1000 procedures) and with therapeutic colonoscopy was 0.14% (incidence: 1.4/1000 procedures). Of gastroscopy procedures the rate with therapeutic gastroscopy was 0.15% (incidence: 1.5/1000 procedures). No perforations occurred with diagnostic gastroscopy.

CONCLUSION: Gastroscopy and colonoscopy procedures, especially those with therapeutic maneuvers, continue to carry morbidity and mortality risks associated with perforation.

Key Words: Colonoscopy; Complication; Endoscopy; Gastroscopy; Morbidity; Mortality; Perforation

Taux de perforation liés aux endoscopies dans un centre hospitalier universitaire au Canada

CONTEXTE : Malgré les progrès réalisés dans la formation, les techniques d’utilisation et la technologie, les endoscopies digestives hautes et basses comportent toujours des risques de perforation de l’intestin. Les taux de perforation présentés aux patients au moment du consentement proviennent souvent de cohortes historiques et de données d’enquêtes.

OBJECTIF : La présente étude a porté sur les taux de perforation liés aux endoscopies hautes et basses, effectuées dans un grand centre de soins tertiaires au Canada.

MÉTHODE : Nous avons évolué les gastroscopies et les colonoscopies pratiquées sur des patients externes et des patients hospitalisés sur une période de trois ans. Les endoscopies suivies d’une perforation notée dans les 14 jours après l’intervention ont été repérées de façon rétrospective à l’aide des codes de la Classification internationale des maladies, 9e édition, puis récupérées et soumises à une recherche manuelle pour confirmer le lien entre la perforation et l’intervention. L’extraction des données avait pour but de relever les facteurs de risque et les résultats de l’examen.

RÉSULTATS : Au total, 21 217 endoscopies (13 792 gastroscopies et 7425 colonoscopies) ont été passées en revue. Sur ce nombre, 359 ont fait l’objet d’une recherche manuelle en vue d’une confirmation de la perforation, et 18 dossiers se sont avérés des cas de perforation liés à l’endoscopie. Dix perforations ont été associées à la colonoscopie (0,13 %) (incidence : 1,3/1000 interventions), dont une s’est soldée par la mort du patient (0,013 %) (incidence : 0,13/1000 interventions). De son côté, la gastroscopie a été associée à huit perforations (0,06 %) (incidence : 0,6/1000 interventions), et aucune n’a entraîné la mort du patient. En ce qui concerne les colonoscopies, le taux de perforation associé aux interventions diagnostiques était de 0,13 % (incidence : 1,3/1000 interventions) et celui associé aux interventions thérapeutiques, de 0,14 % (incidence : 1,4/1000 interventions). Quant aux gastroscopies, le taux de perforation associé aux interventions thérapeutiques était de 0,15 % (incidence : 1,5/1000 interventions). Pour ce qui est des gastroscopies à visée diagnostique, elles n’ont donné lieu à aucune perforation.

CONCLUSION : Les gastroscopies et les colonoscopies, notamment à visée thérapeutique, comportent toujours des risques de morbidité et de mortalité associés aux perforations.

Upper and lower flexible endoscopy has evolved into an important diagnostic and therapeutic technique that has revolutionized the management of patients with gastrointestinal diseases. Although flexible upper and lower endoscopy, with current endoscopic equipment and appropriate training is considered a safe procedure, like all other procedures in medicine, complications still may occur. One of the most serious of these complications is intestinal perforation.

Table 1 outlines the published reports of colonoscopy-associated perforation rates during the last 30 years. The reported rate of colonic perforation ranges from a high of 1.3% to a low of 0% (1-18). Studies with the highest reported rate of perforations are those conducted at a time when colonoscopy was a relatively new procedure, and may not be representative of current colonoscopic practice. In contrast, retrospective and prospective studies conducted since 1996 have reported lower rates of perforation, with diagnostic colonoscopic perforation
rates ranging from 0.005% to 0.20% (10-16) and therapeutic colonoscopic perforation rates ranging from 0.06 to 0.40% (11-15). Indeed, a recent diagnostic colonoscopic screening program for colon cancer in a healthy population involving over 3000 colonoscopies had a zero rate of perforation (19), implying the risk of colonoscopy-associated perforation may be lowest during screening of a healthy outpatient population.

Table 2 outlines the published reports of gastroscopy-associated perforation rates during the last 30 years. The rate of perforation with diagnostic gastroscopy has been described as lower than that of perforation associated with diagnostic colonoscopy. The rate of perforation at the time of diagnostic gastroscopy ranges from 0.0009% to 0.10% (7,13,20-25).

Again, similar to that seen with colonoscopy, the most recent studies report the lowest rates of perforation. Therapeutic gastroscopy carries an increased risk of perforation (range 0.3% to 6.4%) and is almost always associated with dilation of malignant or benign esophageal strictures (21,25). Interestingly, upper endoscopic perforations associated with bleeding ulcers was not described until recently, when a therapeutic endoscopic upper gastrointestinal bleeding clinical trial documented a perforation rate of 1.1% and 4.2% for endoscopic treatment and re-treatment, respectively (26).

Perforation rates provided to patients at the time of consent are frequently derived from the historical cohorts and survey data sets identified in Tables 1 and 2. There are currently no published Canadian endoscopic perforation data. The aim of
this retrospective chart review was to determine recent Canadian gastroscopy- and colonoscopy-associated perforation rates at a Canadian tertiary care university teaching centre.

METHODS
The University of Alberta Hospital is a university teaching centre and a tertiary care referral hospital located in Edmonton, Alberta. It serves a catchment area of over 1.8 million people from central/northern Alberta, northwestern Saskatchewan, northern British Columbia and the Northwest Territories. Endoscopy at the University of Alberta Hospital is performed by three pediatric gastroenterologists, four hepatologists, six adult gastroenterologists and one general surgeon. Approximately 4500 gastroscopies and 2500 colonoscopies are performed annually. The hospital also serves as a Canadian training centre for between five to 10 gastroenterology subspecialty residents in any given year.

All inpatient and outpatient upper and lower endoscopies conducted at the University Hospital between January 1, 1998 and December 31, 2001 were evaluated. The University of Alberta Hospital uses the International Classification of Diseases (ICD) (27), on a prospective basis, to identify each procedure and diagnosis for every patient encounter. Previous reports have shown that over 90% of perforations resulting from endoscopy are diagnosed within two days of the procedure (12). Endoscopies with perforations, occurring within 14 days of the endoscopic procedure, were therefore isolated using the code descriptions listed in Table 3.

Identified records were retrieved and hand searched to confirm an endoscopic-associated perforation by consensus of two authors (TM and RF). Data were extracted to identify patient demographics, endoscopic indication and diagnosis, type of procedure, extent of insertion, preparation adequacy, trainee involvement, previous abdominal surgery, renal failure, surgical outcome and mortality. The type of procedure was recorded as either diagnostic or therapeutic depending on the presence or absence of a therapeutic endoscopic maneuver. For gastroscopy, therapeutic maneuvers included dilation, stent placement, variceal and nonvariceal hemostatic procedures, and percutaneous endoscopic gastrostomy tube placement. For colonoscopy, therapeutic maneuvers included all therapeutic procedures identified for gastroscopy, plus polypectomy and decompression. The occurrence of mucosal biopsy was recorded as a diagnostic procedure.

### TABLE 2
Published reports of gastroscopy-associated perforation rates during the last 30 years

<table>
<thead>
<tr>
<th>Author year (ref)</th>
<th>Number of procedures</th>
<th>Perforation rate (%)</th>
<th>Mortality rate (%)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic gastroscopy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1972, Schiller et al (22)</td>
<td>23,500</td>
<td>0.11</td>
<td>0.004</td>
<td>Survey</td>
</tr>
<tr>
<td>1974, Mandelstam et al (23)</td>
<td>211,410</td>
<td>0.03</td>
<td>0.002</td>
<td>ASGE survey</td>
</tr>
<tr>
<td>1987, Miller (24) NA</td>
<td>0.008</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>1990, Fruhmorgen and Pfahler (7)</td>
<td>NA</td>
<td>0.01</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>1995, Quine et al (25)</td>
<td>13,036</td>
<td>0.05</td>
<td>0.008</td>
<td>Retrospective multicentre</td>
</tr>
<tr>
<td>2001, Sieg et al (13)</td>
<td>110,469</td>
<td>0.0009</td>
<td>0.0009</td>
<td>Prospective multicentre, outpatient</td>
</tr>
<tr>
<td>Total</td>
<td>358,415</td>
<td>0.03</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>Therapeutic gastroscopy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1992, Muhldorfer et al (21) NA</td>
<td>0.5</td>
<td>0.05</td>
<td>Dilation – bougienage</td>
<td></td>
</tr>
<tr>
<td>1992, Muhldorfer et al (21) NA</td>
<td>0.3</td>
<td>0.50</td>
<td>Dilation – balloon</td>
<td></td>
</tr>
<tr>
<td>1992, Muhldorfer et al (21) NA</td>
<td>5.0</td>
<td>4.00</td>
<td>Esophageal stents</td>
<td></td>
</tr>
<tr>
<td>1992, Muhldorfer et al (21) NA</td>
<td>1.0</td>
<td>2.00</td>
<td>Sclerotherapy</td>
<td></td>
</tr>
<tr>
<td>1992, Muhldorfer et al (21) NA</td>
<td>1.0</td>
<td>NA</td>
<td>Hemostasis nonvariceal bleed</td>
<td></td>
</tr>
<tr>
<td>1992, Muhldorfer et al (21) NA</td>
<td>5.0</td>
<td>2.00</td>
<td>Laser treatment</td>
<td></td>
</tr>
<tr>
<td>1995, Quine et al (25)</td>
<td>554</td>
<td>1.1</td>
<td>0.50</td>
<td>Retrospective multicentre: dilation of benign stricture</td>
</tr>
<tr>
<td>1995, Quine et al (25)</td>
<td>220</td>
<td>6.4</td>
<td>2.30</td>
<td>Dilation of neoplastic stricture</td>
</tr>
<tr>
<td>Total</td>
<td>2.6</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ASGE American Society for Gastrointestinal Endoscopy; NA Not available

### TABLE 3
ICD code descriptions for endoscopies with perforations

<table>
<thead>
<tr>
<th>Endoscopic procedures</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anoscopy</td>
<td>Accidental cut/hemolysis during surgery</td>
</tr>
<tr>
<td>Closed biopsy of large intestine</td>
<td>Accidental cut/hemolysis with scope</td>
</tr>
<tr>
<td>Closed biopsy of rectum</td>
<td>Accidental puncture/faceration during procedure</td>
</tr>
<tr>
<td>Colonoscopy</td>
<td>Hemorrhage of the gastrointestinal tract</td>
</tr>
<tr>
<td>Dilation of anal sphincter</td>
<td>Other specific disorders rectum/anus</td>
</tr>
<tr>
<td>Dilation of esophagus</td>
<td>Perforation of intestine</td>
</tr>
<tr>
<td>Dilation of intestine</td>
<td>Peritonitis</td>
</tr>
<tr>
<td>Dilation of pylorus</td>
<td>Pneumonitis</td>
</tr>
<tr>
<td>Dilatation of rectum</td>
<td>Pneumoniasis</td>
</tr>
<tr>
<td>Esophagogastroduodenoscopy</td>
<td>Pneumoperitoneum</td>
</tr>
<tr>
<td>Esophagoscopy</td>
<td>Pneumothorax</td>
</tr>
<tr>
<td>Flexible sigmoidoscopy</td>
<td>Gastroscopy</td>
</tr>
<tr>
<td>Other endoscopy small intestine</td>
<td></td>
</tr>
<tr>
<td>Percutaneous gastrostomy</td>
<td></td>
</tr>
<tr>
<td>Polypectomy</td>
<td></td>
</tr>
<tr>
<td>Rigid protosigmoidoscopy</td>
<td></td>
</tr>
</tbody>
</table>

ICD International Classification of Diseases
RESULTS
As shown in Table 4, a total of 21,217 endoscopies (13,392 gastroscopies [diagnostic 8062, therapeutic 5330] and 7425 colonoscopies [diagnostic 4470, therapeutic 2955]) were performed in the 36 months between August 1998 and August 2001. Three hundred fifty-nine (167 inpatients and 192 outpatients) records were initially isolated for review based on the search criteria outlined above. Of these 359 cases, 358 were retrieved. One record of a colonoscopy was not reviewed because it was missing from the files. After hand searching all 358 retrieved cases, 18 of these records were found to have had an endoscopy-associated intestinal perforation.

Colonoscopy
Ten colonic perforations occurred during the 7425 colonoscopies, representing an overall colonoscopic perforation rate of 0.13% (incidence, 1.3/1000; 1/769 procedures) (Table 3). Six colonoscopy-associated perforations occurred during 4470 diagnostic colonoscopies (0.13%) (incidence, 1.3/1000; 1/769 procedures), while four colonoscopy-associated perforations occurred during 2955 therapeutic colonoscopies (0.14%) (incidence, 1.4/1000; 1/714 procedures).

Table 5 demonstrates the characteristics of patients withcolonoscopic perforation. The mean age was 60.3±6.2 years with male:female ratio of 4:6. One patient died following the perforation (0.013%) (incidence, 0.13/1000; 1/7692 procedures). Of the 10 colonic perforations, four of 10 (40%) were undergoing a therapeutic colonoscopic procedure (dilation of benign stricture, one patient, hemostasis, one patient, decompression, one patient, polypectomy, one patient). Of the six perforations in patients undergoing diagnostic colonoscopy, five of six (85%) occurred in association with the following comorbid conditions: two occurred in the setting of diverticulosis, one patient was on hemodialysis, one patient had previous abdominal surgery, and one patient had a combination of diverticulosis, hemodialysis and history of abdominal surgery. Three of 10 (30%) perforations (two therapeutic and one diagnostic colonoscopy) occurred because the colonoscopy was performed in a poorly prepped colon, although the state of the preparation was not reported in four of the perforations, perhaps underestimating the importance of adequate preparation in risk of perforation. Trainees were performing the colonoscopy at the time of perforation in four of 10 (40%) of the cases (four diagnostic colonoscopies).

Management of patients following the identification of perforation varied considerably (Table 6). The diagnosis of perforation was made during the procedure in six of 10 (60%) of the cases and on x-ray, immediately following the procedure, in three of 10 (30%) of the cases and at autopsy in one case (10%). One patient was managed conservatively, two required primary surgical closure, four required surgical resection with anastomosis, two underwent surgical resection with ostomy formation and one died. The one death occurred in a critically ill patient in the intensive care unit, following a recent lung transplant. A colonoscopy was performed up to 30 cm and terminated due to very severe colitis. The patient then became bradycardic and arrested. The autopsy report confirmed an old walled off perforation in the area of the sigmoid, which likely worsened with insufflation of air during the procedure.

Gastroscopy
Eight upper gastrointestinal perforations occurred during the 13,392 gastroscopies, representing a perforation rate of 0.06% (incidence, 0.6/1000; 1.0/1667 procedures) (Table 4). No
gastroscopy-associated perforations occurred during 8062
diagnostic gastroscopies (0%), while eight gastroscopy-associated
perforations occurred during 5330 therapeutic gastro-
scopies (0.15%) (incidence, 1.5/1000; 1/667 procedures).

Table 7 demonstrates the characteristics of the patients
with a perforation during gastroscopy. The mean age of the
patients involved was 62.4±8.2 years with a male:female ratio
of 5:3. Of the eight gastroscopic perforations, all eight (100%)
involved a therapeutic procedure (esophageal dilations for
malignant lesions, six patients, esophageal wall-stent place-
ment, one patient, placement of percutaneous feeding tube,
one patient). Three patients had a positive history of abdomi-
nal surgery. No patients had dialysis-dependent renal failure.
Two of eight (25%) perforations occurred in the setting of
trainee involvement. There were no deaths reported following
any gastroscopic perforations.

Like colonoscopy, the management of perforation following
gastroscopy varied considerably (Table 8). The diagnosis
of perforation was made during the procedure in three of the
cases, and on x-ray, immediately following the procedure,
in five of the cases (chest x-ray, three patients, gastrograffin swal-
low, two patients) Five patients were managed conservatively,
one had an esophageal stent placed in the operating room to
seal the perforation, and two underwent thoracotomies for
esophageal repair. The surgically managed patients were dis-
charged from hospital within 11 days of admission.

DISCUSSION
A review of previous publications suggests that the gastroin-
testinal perforation rate for diagnostic and therapeutic
gastroscopy has remained relatively constant over the last sev-
eral decades (Table 2), whereas the perforation rate for both
diagnostic and therapeutic colonoscopy appears to have fallen,
and then plateaued, during the last decade (Table 1). The
reason for this change in colonoscopic complication rate likely
relates to the more recent introduction of colonoscopy into the
mainstream of gastrointestinal procedures and the advances
that have since occurred in endoscopic equipment, techniques
and operator training. Nevertheless, in these same reported
cohorts (Tables 1 and 2) it is interesting to note that the aver-
age rate of perforation is approximately 85-fold higher for ther-
apeutic gastroscopy (approximately 2.6%) than for diagnostic
gastroscopy (approximately 0.03%); and threefold higher for
therapeutic colonoscopy (approximately 0.24%) than for diag-
nostic colonoscopy (approximately 0.09%); while mortality is
approximately 500-fold higher for therapeutic gastroscopy
(approximately 1.0%) than for diagnostic gastroscopy (approx-
imately 0.002%); and 50-fold higher for therapeutic
colonoscopy (approximately 0.03%) than for diagnostic
colonoscopy (approximately 0.006%).

While over-reporting of perforations was avoided by the use
of hand searching, it is possible that the lower rates of perfora-
tion observed in the current study may reflect under-reporting
by the use of ICD codes to retrieve cases in a retrospective
manner. However, the data obtained in this study are nonethe-
less superior to previous documentation using survey tech-
niques.

Perforation at gastroscopy almost always occurred with dil-
ation of a benign or a malignant esophageal stricture. In
contrast, perforation at colonoscopy occurred with polypectomy,
diverticulosis, poor preparation, previous abdominal surgery
(and presumably adhesions) and dialysis-dependent renal fail-
ure. Except for dialysis, these associations with perforation
have been previously described. Because the prevalence of
these associated diagnoses is likely to be relatively high, it is
not possible to associate these with risk factors for perforation.

The involvement of trainees as a significant factor in endo-
scopic perforation has not been previously confirmed (12).
The current study had trainees involved in a minority of the
cases; however, it was similarly impossible to determine the
risk associated with trainees in that the total number of
doscopic cases the trainees were involved in was not

TABLE 7
Characteristics of patients with perforation following gastroscopy

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex</th>
<th>Age (years)</th>
<th>Procedure</th>
<th>Diagnosis</th>
<th>Trainee associated with the procedure</th>
<th>Previous abdominal surgery</th>
<th>Renal failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>70</td>
<td>Esophageal dilation</td>
<td>Esophageal carcinoma</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>57</td>
<td>Feeding tube placement</td>
<td>Feeding concerns</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>79</td>
<td>Esophageal wall stent placement</td>
<td>Esophageal carcinoma</td>
<td>No</td>
<td>Gastric-esophageal resection</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>17</td>
<td>Esophageal dilation</td>
<td>Esophageal benign stenosis</td>
<td>Yes</td>
<td>Jejunal interposition</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>76</td>
<td>Esophageal dilation</td>
<td>Gastric cardia carcinoma</td>
<td>No</td>
<td>Gastric carcinoma resection, esophageal-jejunal anastomosis</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>86</td>
<td>Esophageal dilation</td>
<td>Esophageal carcinoma</td>
<td>No</td>
<td>Unknown</td>
<td>No</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>47</td>
<td>Esophageal dilation</td>
<td>Achalasia</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>67</td>
<td>Esophageal dilation</td>
<td>Esophageal carcinoma</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
determined. Nevertheless, operator training and experience has been clearly shown to correlate with endoscopic adverse events, including perforation (28).

Reporting of endoscopic complication rates in endoscopic retrospective studies is moving from the use of historical cohort data to site specific data, and more recently, it has been suggested that individual operator rates be recorded and reported (28). In this regard, the perforation rates described in the present report reflect those at the University of Alberta Hospital and may not be relevant to individual operators, or to sites where the risk mix is different than that at the University of Alberta Hospital.

CONCLUSION

In summary, endoscopic gastroscopy and colonoscopy procedures, especially those with therapeutic maneuvers, carry risks associated with perforation morbidity and mortality. Future prospective studies are required to clearly determine the associated comorbid risk factors for endoscopic perforation.

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REFERENCES
