Colonoscopy audit over 10 years—what can be learnt?
Alan G Fraser, Greg D Gamble, Toby R Rose, John P Dunn

Abstract

Introduction The goals of colonoscopy are changing over time and it is important to regularly determine if endoscopists are achieving key performance indicators.

Methods Data on key performance indicators were recorded independently by nursing staff for all colonoscopies performed during a 10-year period. The results were discussed at regular meetings and feedback given to endoscopists.

Results Audit data was recorded for 67,570 procedures. The key performance indicators (time to caecum, withdrawal time, adjusted caecal intubation rate and polyp detection rate) all improved over the audit period (p<0.0001 for trend). For each endoscopist the mean withdrawal time was highly variable ranging from 3.1 mins (95%CI 3.0; 3.1) to 11.2 mins (11.0; 11.3). For each endoscopist mean polyp detection rate varied from 29% (CI 26, 31%) to 69% (CI 68, 70%). There was a significant correlation between mean withdrawal time and mean polyp detection rate for each endoscopist (r=0.42; p=0.03). The polyp detection rate improved from 29% in 1999 to 49% in 2010. The proportion of procedures with more than 2 polyps increased from 22% in 2001 to 33% in 2010. There was a significant association of patient discomfort with time to caecum and also to level of consciousness, p<0.0001. There was a significant decrease in the proportion with significant discomfort over the audit period, p<0.0001.

Conclusions Colonoscopy audit as a routine process with data collection by endoscopy nurses over several years may be able to improve key performance indicators by the process of regular feedback to endoscopists. Audit should be encouraged as a routine process rather than simply as a research tool for a limited period.

Endoscopy units need to be sure that they are delivering high quality endoscopy at levels consistent with recognised standards. It is therefore important to regularly determine if endoscopists are achieving these standards by measuring key performance indicators.1-5

Audit is often collected in an ad hoc manner and not consistent over a long period of time. There is limited data on trends for key performance indicators over time and it remains uncertain whether the audit process is enhancing quality.6,7

This study seeks to determine if practice and performance of colonoscopy is influenced by a consistent audit process by looking for improvement in key performance indicators over a 10-year period. Withdrawal times and polyp detection rates have emerged as important performance indicators but have been found to be highly variable between endoscopists.8-13
This study seeks to determine if endoscopists with longer withdrawal times have higher polyp detection rates and if they are more likely to detect polyps more per procedure. A high standard of colonoscopy service implies that patient discomfort is kept to a minimum.

A deeper level of consciousness may be associated with better tolerance but technical expertise may be a more important determinant of patient discomfort.

Methods

Audit data was collected from two large private endoscopy units in Auckland, New Zealand. Audit data was available from 1999-2010 for Endoscopy Auckland and for 2001 and 2004-2010 for MercyAscot Endoscopy. The audit forms used by each unit were very similar which allowed collation of data for most of the important indicators.

Data was routinely collected at both units on caecal intubation (confirmed by nursing staff), terminal ileum intubation, polyp detection, the number of polyps detected, time to caecum, total time for the procedure and patient tolerance. Data on the number of polyps >1cm and level of consciousness was only collated at Mercy Endoscopy. The caecal intubation rate was adjusted (reaching a malignant obstruction and reaching the neo-terminal ileum post ileo-colic resection were determined as a complete colonoscopy).

Withdrawal time has emerged as an important performance indicator for colonoscopy and a withdrawal time of more than 6 minutes has been recommended. Polyp detection increases withdrawal time because of the time taken for polypectomy. A complicated system of stopping timing of withdrawal during polypectomy can be performed but this is not suitable for large scale continuous auditing. Therefore mean withdrawal times for each endoscopist when no polyps were detected were calculated and correlated with mean polyp detection rate for each endoscopist.

Mean withdrawal times for individual endoscopists were only analysed if data was available for more than 100 procedures. Only patients having conscious sedation using the combination of midazolam and fentanyl were included in the audit. Patient discomfort was graded by the nurse immediately after the procedure and by the by the patient prior to discharge from the endoscopy unit. This was recorded on a 1–5 scale or 0–5 scale (minor difference in scales used in each unit).

A discomfort grade of 3, 4 or 5 was considered to be equivalent for each scoring system (moderate and severe discomfort). Grades of 2 or less were also grouped together (nil or mild discomfort). The deepest level of consciousness during the procedure was recorded by the endoscopy nurse. The level of consciousness was defined as 1=awake; 2=rouses to voice; 3=rouses to touch, 4=rouses to pain and 5=unrousable (scores of 3, 4 and 5 were grouped together).

Statistical analysis was by stepwise logistic regression and trend by two-sided Cochrane-Armitage statistic (SAS).

Results

Trends—Audit data was recorded for 67,570 consecutive procedures (44,066 at Endoscopy Auckland and 23,504 at MercyAscot Endoscopy). The indications were typical for a busy private practice. Colonoscopies were performed for evaluation of new symptoms or the follow-up of individuals with a family history of bowel cancer or a history of previous polyps.

All procedures were performed by consultants with more than 5 years’ experience after specialist training; 69% were performed by gastroenterologists and 31% by surgeons. The mean time to caecum decreased from 9.0 minutes (CI 8.7; 9.4) in 2001 to 7.3 minutes (7.2; 7.5) in 2010, p<0.001.

For all procedures the withdrawal time increased from 7.5 minutes (7.1; 7.8) in 2001 to 8.9 minutes (8.7; 9.0) in 2010, p<0.001.
For procedures where no polyps were detected, withdrawal time increased over the audit period from 5.6 minutes (95%CI 5.3; 5.9) in 2001 to 6.6 minutes (6.4; 6.7) in 2010, p<0.0001 (Figure 1).

**Figure 1. Trends for mean withdrawal time for all procedures and for procedures where no polyps are detected (p<0.001 for both)**

The mean adjusted caecal intubation rate improved from 96.3% in 1999 to 99.0% in 2010. Terminal ileal intubation rate improved from 63% to 87% from 2001 to 2010 (data for Mercy Endoscopy only). Gastroenterologists had higher caecal and ileal intubation rates than surgeons (98.4% vs. 96.4%; 80% vs. 59% and higher rates of polyp detection (45% vs. 39%) all p<0.001. Increasing age (OR 1.01 (CI 1.01, 1.02), p=0.0005 and female gender OR 1.75 (95%CI 1.36, 2.24) (p<0.0001) were independent predictors of not reaching the caecum.

Stepwise logistic regression showed that the adjusted caecal intubation rate was affected by type of training (gastroenterologists compared with surgeons) and year of the procedure (improving with time).

**Polyp detection**—The polyp detection rate improved from 29% in 1999 to 49% in 2010 and the proportion of procedures with more than 2 polyps increased from 22% in 2001 to 33% in 2010, p<0.0001 for both trends. Polyp detection was lower with lower age OR 0.97 (0.96, 0.97), p<0.0001 and higher for males OR 1.43 (1.35, 1.51), p<0.0001.

**Polyp detection and withdrawal time**—Increasing duration of withdrawal time was significantly associated with higher rates of polyp detection for all polyps and for polyps greater than 1cm in diameter (Table 1). For each endoscopist mean withdrawal time (where no polyps were detected) was highly variable ranging from 3.1 minutes (95%CI 3.0; 3.1) to 11.2 minutes (11.0; 11.3). For each endoscopist mean polyp detection rate varied from 29% (CI 26, 31%) to 69% (CI 68, 70%).
Table 1. Polyp detection rate related to withdrawal time

<table>
<thead>
<tr>
<th>Variables</th>
<th>0–5 min</th>
<th>5–10 min</th>
<th>10–20 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyp detection rate</td>
<td>18%</td>
<td>36%</td>
<td>46%</td>
</tr>
<tr>
<td>Odds ratio (all polyps)</td>
<td>1.0</td>
<td>2.5 (2.4; 2.6)</td>
<td>7.7 (7.4; 8.1)</td>
</tr>
<tr>
<td>Odds ratio of detecting polyp &gt;1cm</td>
<td>1.0</td>
<td>1.9 (1.7; 2.1)</td>
<td>3.9 (3.5; 4.3)</td>
</tr>
</tbody>
</table>

Figure 2. Correlation of mean polyp detection rate with mean withdrawal time for endoscopists with more than 100 procedures

There was a significant correlation between mean withdrawal time and mean polyp detection rate for each endoscopist (r=0.42; p=0.03) (Figure 2). There was also a correlation between detection of polyps >1cm and mean withdrawal time for each endoscopist (r=0.51; p=0.0025) and also number of polyps >2 and withdrawal time (r=0.40; p=0.013) when weighted by annual volume of each endoscopist.

**Patient discomfort**—Data was available for 33,337 procedures on patient discomfort and level of consciousness. The patient discomfort score was >2 for 9% of procedures (9.8% of procedures if the score was rated by the endoscopy nurse). There was close concordance in scores between the doctor and nurse (kappa=0.63) and between the patient and doctor (kappa=0.63) and but not between patient and nurse (kappa=0.22).
Ratings of patient discomfort were higher for female gender OR 1.30 (1.23, 1.37). There was a significant association of patient discomfort with time to caecum, p<0.0001 (Table 2). The level of consciousness was rated as 1=awake in 34.4% of procedures; 2=rouses to voice for 63%; 3=rouses to touch for 2%, 4=rouses to pain for 0.4% and 5=unrousable for 0.2% of procedures (scores of 3, 4 and 5 were grouped together). By logistic regression a patient discomfort score of 3, 4, or 5 was related to time to caecum and to level of consciousness (Table 3).

**Table 2. Patient reported discomfort levels related to time to caecum**

<table>
<thead>
<tr>
<th>Discomfort</th>
<th>Time to caecum (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0–5</td>
</tr>
<tr>
<td>0,1,2 (less)</td>
<td>29%</td>
</tr>
<tr>
<td>3,4,5 (more)</td>
<td>8%</td>
</tr>
</tbody>
</table>

**Table 3. Logistic regression of significant factors associated with patient discomfort score of >than 2**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Relative risk</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOC 3,4,5 versus 1,2</td>
<td>0.73</td>
<td>0.57; 0.94, p=0.02</td>
</tr>
<tr>
<td>Time to caecum (min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5–10 versus 0–5</td>
<td>2.2</td>
<td>1.8; 2.6 p&lt;0.0001</td>
</tr>
<tr>
<td>10–15 versus 0–5</td>
<td>5.5</td>
<td>4.5; 6.6 p&lt;0.0001</td>
</tr>
<tr>
<td>&gt;15 versus 0–5</td>
<td>12.0</td>
<td>9.8; 14.7 p&lt;0.0001</td>
</tr>
<tr>
<td>Volume &gt;600 versus&lt;600</td>
<td>1.1</td>
<td>0.9; 1.3 n.s.</td>
</tr>
</tbody>
</table>

The mean time to caecum for each endoscopist was significantly correlated with the proportion of procedures that had a patient discomfort score of 3, 4 or 5 for each endoscopist, r=0.90, p<0.0001 (excluding endoscopists with volume less than 500), Figure 3.
Figure 3. Correlation of patient discomfort scores with time to caecum for endoscopists with annual volume greater than 500 cases

There was a significant inverse relationship between mean annual volume of procedures for each endoscopist and patient discomfort ($r=-0.71$, $p<0.0001$) Figure 4. There was a significant decrease in the proportion with discomfort $>2$ over the audit period from 20% in 1999 to 7% in 2009/10 ($p<0.0001$).

Figure 4. Correlation of patient discomfort scores with mean annual volume of endoscopists

Excludes those with fewer than 100 cases
Discussion

There were significant changes in practice and performance over the 10-year time period. Key performance indicators significantly improved over the audit period. In particular, the rate of polyp detection, the rate of terminal ileal intubation and the withdrawal time all increased over the audit period. This may be a result of the audit process but general learning effects, improvement in equipment and the results of attendance at workshops and courses cannot be excluded.

The standards were generally high but continued to improve. This study shows that continuous audit over 10 years can lead to better outcomes even for experienced endoscopists however it is clear that many factors are involved in improving quality. There has been a significant improvement in the performance of colonoscopy in the UK over the last seven years with the caecal intubation rate improving from 76.9% to 95.8% related to a combination of interventions.  

There was significant attention given to polyp detection rates at annual audit meetings and this may have led to increased detection rates. The recommendation to increase withdrawal times has been implemented to some degree during the audit period. The data supports this as a key strategy for improving polyp detection rates (both for small and larger polyps) and also for increasing the number of polyps detected per procedure. Therefore the criticism that increased withdrawal times only increases detection of smaller polyps does not seem to be justified.

Better patient tolerance of colonoscopy has been achieved over the audit period consistent with improvement in other areas of technical performance. The patient discomfort score was significantly associated with time to caecum. This may be partly because longer procedures are by definition more difficult, but time to caecum is also likely to be a marker of technical expertise. This is suggested by the significant correlation of patient discomfort with mean time to caecum for individual endoscopists and the inverse relationship with mean annual colonoscopy volume for each endoscopist. This analysis eliminates the potential bias that longer procedures will be more uncomfortable assuming that the case mix of difficulty is similar for all endoscopists.

Ekkelkenkamp showed a significant negative correlation between caecal intubation rate (also a marker of technical expertise) and a nurse-reported comfort rating (r=−0.57; p<0.005). This study shows that only a mild decrease in patient discomfort scores is obtained by giving more sedation and achieving deeper levels of consciousness (OR 0.73 for LOC of 3, 4 or 5 compared with LOC 1 and 2, Table 3). These deeper levels of consciousness were only recorded for 2.6% of procedures and are not part of the desired goals of conscious sedation.

This study also shows that females are more likely to experience discomfort during a colonoscopy similar to other studies. Hazeldine found that the degree of sedation had no effect of patient tolerance but females, a high BMI and having a trainee perform the procedure was associated with more discomfort.  

There was a high degree of variability amongst endoscopists in polyp detection rate (29 to 69%). A similar variation in polyp detection rate was reported by Williams et al
with a polyp detection rate ranging from 18% to 66% for men and 11% to 43% for women. This audit was considered part of routine practice rather than a research project. The long-term and continuous nature of the audit probably lead to less interest in gaming the system (trying to find diminutive and non-adenomatous polyps) and encouraged steady behavioural change.

Withdrawal time is an easily influenced behaviour but improvement in polyp detection also requires greater vigilance and attention to detail during the procedure. A recent study has shown that a group of endoscopists who participated in a 2-hour training session were able to increase adenoma detection rate from 36% to 47% whereas the adenoma detection rate did not change for a group who did not receive training. The improvement was seen for all polyps types and for larger as well as small polyps.

Regular feedback to the endoscopist was also an important aspect of the improvement. Other studies have shown that monitoring and regular feedback leads to a decrease in incomplete colonoscopies, shortened intubation times and increased withdrawal times although these studies did not clearly show an increase in adenoma detection.

The frequently of feedback may be important. A study using a quarterly report card summarizing colonoscopy quality indicators showed an increased adenoma detection (adjusted for age and sex) from 45% to 54%, p=0.013. This increase was due mostly to increased detection of proximal adenomas.

Overall polyp detection or polypectomy rate is appears to be correlated with adenoma detection rate suggesting that the simpler measure of polyp detection may be adequate. Achieving a polypectomy rate of 40% for men and 30% for women correlated with recommended adenoma detection rates of 25% for men and 15% for women.

The polypectomy rate may prove to be a useful measure as there is growing recognition that some nonadenomatous polyps such as large hyperplastic or sessile serrated polyps are a significant risk of colorectal cancer and therefore need to be carefully identified and removed. The detection of proximal serrated polyps is highly variable and endoscopist dependent.

A significant proportion of proximal serrated polyps may be missed during colonoscopy. A study of 18003 colonoscopies showed a mean serrated detection rate of 20.6% and mean adenoma detection of 31.5%. There was no correlation between adenoma detection rate and serrated polyp detection rate but there was a strong relationship between time of withdrawal and serrated polyp detection rate (r=0.956, p=0.003).

There are some limitations to this study. The data was obtained from an audit process rather than from a research project. The data recorded needed to be achievable within standard working practice i.e. not too time consuming. In particular, withdrawal time was derived from total procedural time minus time to caecum. This has limitations (i.e. does not allow for variation in ileal intubation time or time taken to perform polypectomy) but is easy to use. The large number of observations helps to offset this limitation to some extent.
Routine audit becomes very difficult using a stopwatch recording approach i.e. starting only after ileal intubation and also stopping during polyp removal. The analysis using endoscopists withdrawal time where no polyps were detected is a valid way of using this data. More data on indications for endoscopy, particularly clarifying which patients were follow-up and which patient had new symptoms for initial evaluation would have been helpful.

The audit process was considered a success by all endoscopists and this is now considered as part of the standard of care for both endoscopy units. The goal is to continue to improve key performance indicators, particularly polyp detection rate.

Improving standards of colonoscopy throughout New Zealand is an important issue to consider before introducing bowel cancer screening which will significantly increase the number of individuals having a colonoscopy.

A new quality measure called the Global Rating Scale is being introduced to endoscopy units throughout New Zealand. This should encourage the routine adoption of a similar audit process to that described in this paper. Conscious sedation is acceptable for colonoscopy but continued attention to improving technical expertise is required to continue to decrease patient discomfort levels.

Competing interests: None identified.

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References:
4. Quality and safety indicators for endoscopy. Formulated by the BSG Endoscopy Committee in conjunction with the National Bowel Cancer Screening Programme, AUGIS and ACP. www.bsg.org.uk/attachments/170_bsg_grs_indic07.pdf