Digestive and Liver Disease 46 (2014) 176–181

Contents lists available at ScienceDirect

Digestive and Liver Disease

journal homepage: www.elsevier.com/locate/dld

Oncology

The mean number of adenomas per procedure should become the gold standard to measure the neoplasia yield of colonoscopy: A population-based cohort study

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ARTICLE INFO

Article history:
Received 8 April 2013
Accepted 7 August 2013
Available online 18 September 2013

Keywords:
Adenoma
Colonoscopy
Colorectal neoplasms
Diagnosis
Mass screening
Occult blood
Quality improvement
Standards

ABSTRACT

Background: Measuring adenoma detection is a priority in the quality improvement process for colonoscopy. Our aim was (1) to determine the most appropriate quality indicators to assess the neoplasia yield of colonoscopy and (2) to establish benchmark rates for the French colorectal cancer screening programme.
Methods: Retrospective study of all colonoscopies performed in average-risk asymptomatic people aged 50–74 years after a positive guaiac faecal occult blood test in eight administrative areas of the French population-based programme.
Results: We analysed 42,817 colonoscopies performed by 316 gastroenterologists. Endoscopists who had an adenoma detection rate around the benchmark of 35% had a mean number of adenomas per colonoscopy varying between 0.36 and 0.98. 13.9% of endoscopists had a mean number of adenomas above the benchmark of 0.6 and an adenoma detection rate below the benchmark of 35%, or inversely. Correlation was excellent between mean numbers of adenomas and polyps per colonoscopy (Pearson coefficient $r = 0.90$, $p < 0.0001$), better than correlation between mean number of adenomas and adenoma detection rate ($r = 0.84$, $p = 0.01$).
Conclusion: The mean number of adenomas per procedure should become the gold standard to measure the neoplasia yield of colonoscopy. Benchmark could be established at 0.6 in the French programme.

1. Introduction

A growing number of countries undertake colorectal cancer (CRC) screening programmes with faecal occult blood test (FOBT), flexible sigmoidoscopy or colonoscopy. These screening methods lead to colonoscopy for detection of early-stage cancers and removal of adenomatous polyps. However, colonoscopy is an operator-dependent examination, and adenoma and polyp detection vary dramatically between endoscopists [1–10]; high adenoma detection rate (ADR) and polypectomy rate (PR) are associated with a lower risk of interval CRC [11,12]. Measuring the neoplasia yield is a priority in the quality improvement process for colonoscopy but there is no agreement concerning which quality indicator should be used, nor the standard threshold that should be attained [13]. There is no ideal and universal neoplasia yield indicator; the same is true for benchmarks set for minimum detection rates which depend on the details of CRC screening programmes. Adenoma detection rate (ADR) is the most commonly recommended neoplasia-related quality indicator [14–16]. However, the mean number of adenomas (MNA) per colonoscopy is a better reflection of full length

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1590-8658/$36.00
http://dx.doi.org/10.1016/j.dld.2013.08.129

of colon examination and "could prove to be the ideal measure of adenoma detection" [14,16]. Moreover, both MNA and ADR are seldom measured in routine practice because their calculation is rather complex as they share the same drawback of waiting for the pathology report before determination. Other indicators such as polyp detection rate (PDR), PR and mean number of polyps (MNP) per colonoscopy have been proposed [17–20]. In a previous exploratory study, we advocated the use of MNP, which is well correlated with ADR and MNA and much easier to measure [19]. In our prior work, we examined a relatively small number of endoscopists practicing in a few geographic areas.

The aim of this study was (1) to determine on a larger scale the most appropriate quality indicators to assess the neoplasia yield of colonoscopy and (2) to establish benchmark rates for the French organized CRC screening programme with guaiac-based FOBT (gFOBT).

2. Patients and methods

2.1. Screening programme

A pilot gFOBT CRC screening programme was implemented in several French administrative areas from 2002 on. Its design has been previously described [21]. Briefly, residents aged 50–74 years were invited by mail every other year to participate. People with serious illness, recent CRC screening or high CRC risk were excluded. The gFOBT (Hemoccult II) was used without dietary restriction and was processed without rehydration. Faecal material was assessed from two samples from each of three consecutive stools. The test was defined as positive if at least one window was positive. People with a positive gFOBT were referred for colonoscopy.

2.2. Colonoscopies

All the colonoscopies performed within the gFOBT screening programme in eight administrative areas (Supplementary Fig. S1) (2.0 million residents aged 50–74 years) from December 2002 to December 2010 were assessed to compare different yield indicators, specify their determinants and determine a threshold between higher and lower detectors. Endoscopists who had performed 30 procedures or more were evaluated. As usual in France, all colonoscopies were performed by gastroenterologists and most of them (95%) under sedation/anaesthesia provided by an anaesthetist.

2.3. Pathological classification

The pathological examination of detected polyps and CRCs was performed as usual, mostly by community general pathologists. The result of each colonoscopy was classified according to the lesion with the worst prognosis. Cancer was defined as carcinoma invading at least the submucosa across the muscularis mucosa [22]. In situ and intramucosal carcinomas were classified as high-grade neoplasia. Advanced adenoma was defined as an adenoma measuring $\geq$10 mm or with a villous component >20% or with high-grade dysplasia.

2.4. Yield indicators

ADR and PDR were defined respectively as the percentages of colonoscopies where at least one adenoma and one polyp were found. MNA and MNP were defined respectively as the overall number of adenomas and polyps detected divided by the number of colonoscopies performed. Colonoscopies displaying invasive cancer were excluded for the calculation of these yield indicators. ADR, PDR and MNP were measured in all eight administrative areas, whereas MNA was measured in five areas only.

2.5. Statistical methods

Qualitative variables (ordered or nominal) were described by their frequency and quantitative variables by their median, range, mean and standard deviation (SD). Pearson coefficients were determined to search for correlations between variables and compared using a normal Fisher transformation. The chi-square test was used for comparison of caecal intubation rates and frequencies of higher detectors between the eight administrative areas.

The goal of multivariate analysis was to find among age and sex of patients, number of positive windows, number of previous tests performed before the positive gFOBT, year of colonoscopy, administrative area and number of colonoscopies performed by the endoscopist, those variables having an effect on the number of polyps and adenomas detected. There were however two levels of data since several colonoscopies (first level) were performed by endoscopists (second level) practicing in a given administrative area. Therefore, we built Bayesian multilevel mixed models [23]. In Bayesian analyses, a prior knowledge on parameters is updated by gathered data and yields posterior knowledge. The prior knowledge is summarized under prior distribution on each parameter (here rather vague distributions). Using simulation techniques (Markov chains and Monte Carlo integration), the posterior distributions are summarized with their empirical means (posterior mean in the sequel of the article) and some of their percentiles: 2.5th and 97.5th percentiles give rise to a 95% credible interval (CI) (analogous to confidence interval in frequentist statistics). The Bayesian framework allows fitting complex multilevel models. In a linear regression model including covariates, we added nested effects for endoscopists and for administrative areas. Comparison between models used a deviance information criterion (DIC), the Bayesian version of the Akaïke score (AIC) [24]. Using the cut-off established at 0.8 for MNP for the definition of higher detectors in our previous study [19], we estimated the cut-off for MNA, ADR and PDR by maximizing each of the corresponding kappa agreement statistics. Comparing the percentages of endoscopists classified similarly as higher or lower detectors with each indicator and with the gold standard, MNA, gave an assessment of their relative performances. These analyses used Bayesian inference for agreement models [25]. The benchmark rates were then calculated for all indicators by rounding the corresponding cut-off while maintaining an acceptable rate of higher detectors situated around 60–65%.

3. Results

A total of 42,817 colonoscopies were performed by 316 endoscopists. Table 1 shows their distribution by administrative area. A measure of MNA was available in 202 endoscopists. The mean age of the patients was 62.5 years (SD 7.0); 22,554 (52.7%) colonoscopies were performed in men. The mean number of procedures by endoscopist was 135 (SD 105; range 30–543). The caecal intubation rate was 96.7%. It varied from 95.2% to 97.8% depending on the administrative area ($p = 0.99$) (Table 1). Overall, 17,090 colonoscopies (39.9%) displayed a neoplasia, 2438 (5.7%) a cancer, 9184 (21.4%) an advanced adenoma, and 5468 (12.8%) a non-advanced adenoma. The overall ADR was 36.3% (26.6% in women, 45.0% in men).

Table 1 shows the median, mean, and SD of the main yield indicators observed in both sexes in the whole study. ADR ranged from 12.8% to 73.1% (mean 36.8%; SD 9.9), PDR from 12.8% to 88.5% (mean 49.2%; SD 13.5), MNA from 0.2 to 1.7 (mean 0.71; SD 0.28) and MNP from 0.2 to 3.6 (mean 1.03; SD 0.47). Using the overall cut-off of 0.8