Surveillance in Barrett's Oesophagus: Will a Strategy Focused on a High-Risk Group Reduce Mortality from Oesophageal Adenocarcinoma?

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Background and Study Aims: The incidence of oesophageal adenocarcinoma has increased significantly in recent years. While surveillance of people with Barrett's oesophagus, its usual precursor, has been advocated in order to detect dysplasia and early cancer in those considered to be at greatest risk, the impact of such a strategy on survival from oesophageal adenocarcinoma is unclear. This study aimed to determine the effect of surveillance on mortality from oesophageal adenocarcinoma in a group of patients considered to be at high risk of developing Barrett's oesophagus and adenocarcinoma.

Patients and Methods: After performing a Medline search of the literature published between 1985 and 2004 for studies on gastro-oesophageal reflux disease, Barrett's oesophagus and adenocarcinoma, we examined the impact of surveillance on mortality from oesophageal adenocarcinoma in a hypothetical sample of 100 high-risk patients (men aged over 50 with Barrett's oesophagus but without high-grade dysplasia at entry).

Results: Four patients in this high-risk group developed adenocarcinoma during surveillance, with survival rates of 78.9% (95%CI 64.9%–88.5%) at 2 years and 78.6% (95%CI 62.8%–89.2%) at 5 years. Meanwhile, between 515 and 2060 patients with Barrett's oesophagus were not detected or surveyed by this strategy and between 16 and 61 of these developed adenocarcinoma, with much lower survival rates of 37.1% (95%CI 25.4%–50.3%) at 2 years and 16.7% (95%CI 9%–28.3%) at 5 years. Although surveillance in the high-risk group resulted in the long-term survival of three patients who would not otherwise have survived, this gain was dramatically offset by the 13 to 51 patients, excluded from surveillance by this strategy, who died from oesophageal adenocarcinoma.

Conclusions: A surveillance programme based on current concepts of risk cannot have an impact on mortality from oesophageal adenocarcinoma. To be effective, it will be necessary for surveillance programmes to utilise more precise methods for the identification of those who are most at risk of progression to adenocarcinoma.

Introduction

Barrett's oesophagus, regarded as the most severe histological consequence of chronic gastro-oesophageal reflux [1], is defined by the replacement of the stratified squamous epithelium of the distal oesophagus by a specialised, intestinal-type columnar mucosa [2]. Barrett's oesophagus is the cardinal precursor of adenocarcinoma of the oesophagus [1]; the route from reflux to adenocarcinoma is considered to comprise a stepwise progression from metaplasia, through low-grade and high-grade dysplasia to invasive carcinoma and metastatic disease [3–5]. Most studies have reported that the risk of developing adenocarcinoma is 30 to 125 times higher in people with Barrett's oesophagus [6], with an estimated annual risk of developing this cancer of between 0.5% and 1% in such patients; others, however, have cautioned that this cancer risk may have been overestimated in the literature as a consequence of publication bias [7].

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The incidence of oesophageal adenocarcinoma has increased fivefold over the past 25 years [8], although most cases of adenocarcinoma continue to be diagnosed at an advanced stage. This has led to the advocacy of screening and surveillance strategies which aim to detect adenocarcinoma or precursor lesions early [9]. However, to date, the benefits of these interventions have not been confirmed in prospective studies and remain, in the main, inferred from indirect evidence. Furthermore, there is, so far, little evidence that the surveillance programmes currently in place have prevented deaths from oesophageal adenocarcinoma. For example, as few as 5% of patients who undergo resection surgery for oesophageal adenocarcinoma have a prior diagnosis of Barrett's oesophagus [10]. In addition, other studies have shown that as many as 40% of patients with oesophageal adenocarcinoma deny having a history of reflux symptoms at the time of diagnosis [11].

The issue of surveillance is further complicated by the many variables that are involved in deciding on the real benefits of this approach. Examples include the incidence of dysplasia or of oesophageal adenocarcinoma in the population to be evaluated; the accuracy of the diagnostic methods employed in the detection of Barrett's mucosa, dysplasia and cancer; the risks and impact on the quality of life of the procedure(s) employed in the surveillance programme; patient compliance; and, finally, the mortality and morbidity associated with the surgical procedure(s) employed for the definitive treatment of adenocarcinoma and of high-grade dysplasia.

The aim of this study was to critically evaluate, in a clinically meaningful way, the impact of surveillance on mortality from adenocarcinoma of the oesophagus in a group of patients who were considered to be at high risk.

Patients and Methods

A systematic search of the Medline database for the period from 1985 to 2004 was performed to identify potentially relevant published trials. We reviewed all the English-language abstracts with "Barrett's" as a text word or subject heading, together with one of the following words: "epidemiology", "dysplasia", "adenocarcinoma", "therapy", "economics", "surgery", "complications", "mortality", and "survival". Pertinent studies from reference lists in these manuscripts and from review articles were also evaluated in search of studies not identified in the first search. To address each of the decision points, we relied on data from randomised controlled trials, case-control data and cohort studies. Studies were included if they reported relevant information on any of the issues to be addressed.

We then used this information to evaluate the impact of surveillance on a hypothetical cohort of 100 patients who were considered to be at high risk of Barrett's oesophagus and progression to adenocarcinoma – men over the age of 50 who had classic reflux symptoms and who, at initial endoscopy, were found to have Barrett's oesophagus but no evidence of high-grade dysplasia. In evaluating the impact of surveillance on mortality from adenocarcinoma we made the following assumptions:

- "Barrett's oesophagus" was defined as any length of endoscopically-evident, salmon-coloured mucosa in the tubular oesophagus which was found on histological evaluation to contain specialised intestinal metaplasia [2].
- Barrett's oesophagus was identified by performing endoscopy in patients with typical and chronic symptoms of gastro-oesophageal reflux.
- Patients referred for endoscopy on the basis of the presence of any symptoms or signs that would arouse a suspicion of adenocarcinoma (e.g. dysphagia, weight loss, or gastrointestinal bleeding) were excluded from the analysis.
- Surveillance was performed by endoscopy with multiple biopsies of the columnar-appearing mucosa. The intervals between endoscopies and the biopsy protocols varied between surveillance strategies; this study did not differentiate between surveillance strategies; data from any surveillance strategy was included.
- Patients in whom high-grade dysplasia or adenocarcinoma was identified and confirmed were referred for oesophagectomy. It was also assumed that patients who were judged to be unfit for oesophagectomy were not included in the surveillance programme *ab initio*.
- Patients were compliant with the protocol. Although it has been found that as few as 50% of patients will be completely compliant with any surveillance protocol, the available literature did not permit an analysis of outcome for those who were partially compliant; our analysis therefore assumes that all who entered a surveillance programme completed it.

We then performed a theoretical evaluation of surveillance efficacy in our patient cohort, based on available published data: we looked specifically at the rate of occurrence of oesophageal adenocarcinoma, the outcomes for patients with adenocarcinoma in terms of surgical mortality and morbidity, and 2- and 5-year survival rates. These results were compared with those of a reference cohort of Barrett's patients who had developed adenocarcinoma but who would not have been identified by the surveillance strategy (this data was also derived from the literature).

For all outcomes, rates (based on a weighted average to allow for differences in sample size) and 95% confidence intervals were calculated from the data available in the literature, using the methods described by Fleiss [12] using S-PLUS 2000 statistical software. We also performed a sensitivity analysis: sensitivity, specificity, false-positive and false-negative rates, and positive and negative predictive values were calculated and confidence intervals estimated using Wilson's continuity corrected method [12].

Results

A total of 109 English-language studies and abstracts were reviewed. Figure **1** traces the pathway to the identification of our high-risk cohort of 100 men aged over 50 who had Barrett's oesophagus but who did not have high-grade dysplasia. To arrive at this group we had to evaluate 1372 patients with chronic reflux symptoms, of whom 177 had Barrett's oesophagus: 74 of these would have been excluded from surveillance either because they were female (n = 56) or because they were aged under

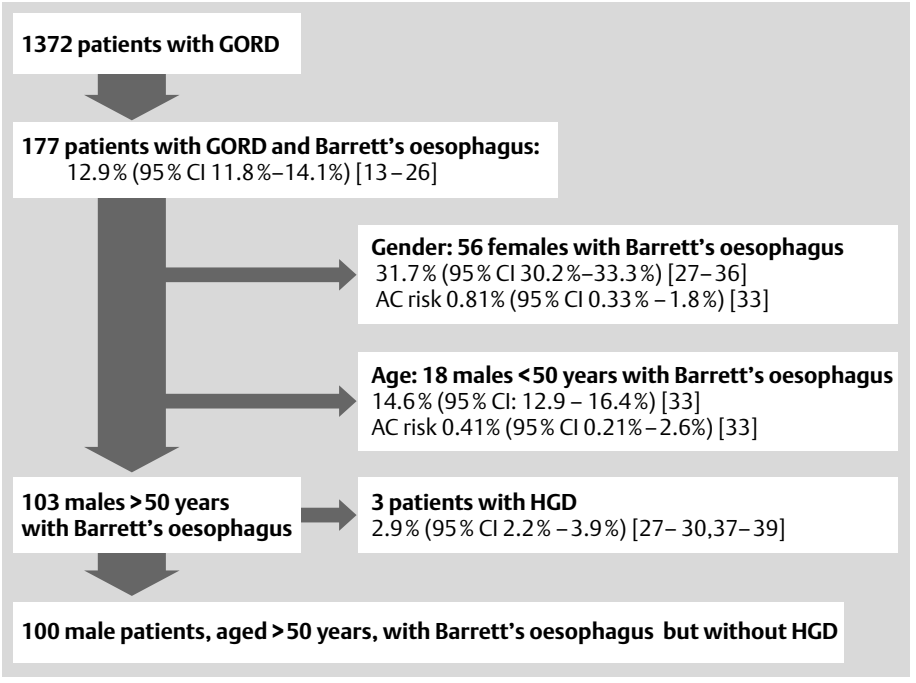

Figure **1** Identification of the high-risk group of 100 male patients with Barrett's oesophagus but without high-grade dysplasia, from 1372 patients with gastro-oesophageal reflux disease (GORD). The adenocarcinoma (AC) risk for the excluded patients (female patients and male patients aged under 50) is stated.

50 (n = 18); three further patients were found to have high-grade dysplasia at their index endoscopic examination, proceeded to definitive therapy, and therefore did not undergo surveillance. Meanwhile, between 515 and 2060 patients with Barrett's oesophagus remained undetected, usually because they were asymptomatic or had undiagnosed gastro-oesophageal reflux disease. This meant that the ratio for diagnosed to undiagnosed Barrett's oesophagus was 1 : 5 to 1 : 20 [40,41].

Table **1** summarises the outcome for our 100 patients. While it must be acknowledged that, in reality, only 52 patients (51.8%, 95%CI 45.1% – 58.4%) would have complied fully with the surveillance programme [27,46], we assumed full compliance for the purposes of this exercise. Ten of our patients were found to have low-grade dysplasia at baseline; on review, this pathological diagnosis was confirmed in seven of these patients (64.7%, (95%CI 38.6% – 84.7%) [45].

Overall, 13 of these 100 patients showed progression of their pathological lesion during surveillance: nine to low-grade dysplasia; three to high-grade dysplasia; and two to oesophageal adenocarcinoma (1.44 patients from the group that initially had no dysplasia and 0.37 from the group that initially had low-grade dysplasia, i. e. 1.81 for the groups combined, rounded off to 2). Of the three patients who showed progression to high-grade dysplasia, two were subsequently found in fact to have adenocarcinoma, one at a second endoscopy and one at the time of surgery. Meanwhile, among the patients in the low-grade dysplasia group, six showed regression and two remained unchanged.

Table **2** summarises the outcomes for patients who developed adenocarcinoma of the oesophagus, both for those in the surveillance cohort and for those who did not enter a surveillance protocol. Of the four patients who developed cancer while they were under surveillance, all survived surgery and three survived for at least 5 years; without surveillance, only one patient would have survived, a net gain of two lives. However, for the 16 – 61 patients who developed cancer among the 515 – 2060 patients with Barrett's oesophagus who were not identified by the surveillance strategy, between 13 and 51 died; with surveillance, only 3 – 13 would have died. The net loss for our surveillance strategy was, therefore, between 10 and 38 patients. As shown in Table **3**, this difference in outcome is largely attributable to the differences between the two groups in disease stage at the time of diagnosis.

For the sensitivity analysis, raw data from the studies in references [1], [27 – 30], [32 – 34], [37], [46 – 56] provided the surveillance group and raw data from the studies in references [78 – 80] provided the "non-surveillance" group. The results of the sensitivity analysis are summarised in Table **4**.

Discussion

Because of the strong association between Barrett's oesophagus and oesophageal adenocarcinoma, many experts recommend periodic endoscopic surveillance of patients with Barrett's oesophagus [9,81]. The rationale for endoscopic surveillance in patients with Barrett's oesophagus is to detect early stages in the progression of disease toward cancer and to allow early intervention, while cure is still likely. The outcome of any surveillance programme can be looked at from two perspectives: that of the individual patient and that of the community at large. We chose to address the latter issue and to evaluate the effects of surveillance on overall survival from oesophageal adenocarcinoma. We readily concede that an individual patient who is fortunate enough to have high-grade dysplasia or carcinoma in situ detected at endoscopy for follow-up of Barrett's oesophagus will have a better outcome. The question that we wanted to address, however, was whether such an approach could justify the resources and expenditure involved in such a strategy.

Table **1** The outcome for our high-risk group of 100 patients with Barrett's oesophagus but without high-grade dysplasia (HGD), according to whether they were found at baseline to have low-grade dysplasia (LGD) or no dysplasia at all

	Patients with Barrett's oesophagus but without HGD (n = 100)	
	Patients with no dysplasia	***Patients with LGD***
Patients at baseline, n (CI) [study references]	90 90.3 % (95 %CI 88.5 % – 91.7 %) [27 – 30, 37, 39]	10 10.5 % (95 %CI 9.3 % – 11.8 %) [27 – 30, 35, 37, 39, 42 – 44]
Progression, n (CI) [study reference no.]		
LGD	9 10.4 % (95 %CI 8.4 % – 12.6 %) [27 – 30, 37, 42]	–
HGD	1 1.3 % (95 %CI 0.48 % – 3.2 %) [27, 29, 30, 37, 42]	2 14.9 % (95 %CI 8.5 % – 24.6 %) [29, 30, 37, 42, 45]
Adenocarcinoma	1* 1.6 % (95 %CI 0.92 % – 2.8 %) [27 – 30, 37, 38, 42, 43]	0* 3.7 % (95 %CI 2.6 % – 5.2 %) [27 – 30, 37, 38, 42 – 45]
Regression, n (CI) [study reference no.]	–	6 54.5 % (95 %CI 42.8 % – 65.8 %) [27, 29, 30, 37, 45]
Persisting (unchanged) disease, n (CI) [study reference no.]	79	2 23 % (95 %CI 13.5 % – 35.8 %) [29, 30, 37, 45]

* When the no dysplasia and low-grade dysplasia groups are combined, the number of adencarcinomas increases to two (1.44 + 0.37 = 1.81, rounded off to 2).

Table **2** Outcomes for people in the surveillance and the non-surveillance groups who developed adenocarcinoma. Outcomes are expressed as percentages with 95 % confidence intervals (95 %CI) and the reference numbers are given for the studies used for the data

	Surveillance group	***Non-surveillance group***
Total no. of patients with Barrett's oesophagus	100	515 – 2060
Direct progression to AC during follow-up	2.3 % (95 %CI 1.9 % – 2.8 %) [1, 27 – 30, 32 – 34, 37, 46 – 56] 2 patients	3.4 % (95 %CI 1.9 % – 5.7 %) [78 – 80] 18 – 70 patients
Change of diagnosis from AC to HGD after surgery	12.3 % (95 %CI 5.5 % – 24.3 %) [45, 46, 57 – 61] 0 patients	12.3 % (95 %CI 5.5 % – 24.3 %) [45, 46, 57 – 61] 2 – 9 patients
Change in diagnosis from HGD to AC*		
After second endoscopy	33.3 % (95 %CI 20 % – 49.6 %) [58, 62, 63] 1 patient	—
After surgery	36 % (95 %CI 32.1 %–40.1 %) [28, 57 – 74] 1 patient	—
Total no. of patients with AC	4	16 – 61
Complications		
Minor	21.6 % (95 %CI 11.8 % – 35.7 %) [59] 1 patient	21.6 % (95 %CI 11.8 % – 35.7 %) [59] 3 – 13 patients
Major	6.7 % (95 %CI 2.2 % – 17 %) [59] 0 patients	6.7 % (95 %CI 2.2 % – 17 %) [59] 1–4 patients
Mortality	4.7 % (95 %CI 2.2 % – 9.3 %) [57 – 59, 75] 0 patients	4.7 % (95 %CI 2.2 % – 9.3 %) [57 – 59, 75] 1–3 patients
Survival		
2 years	78.9 % (95 %CI 64.9 % – 88.5 %) [37, 57, 58, 68, 76] 3 patients	37.1 % (95 %CI 25.4 % – 50.3 %) [68, 76] 6 – 23 patients
5 years	78.6 % (95 %CI 62.8 % – 89.2 %) [37, 57, 58, 76, 77] 3 patients	16.7 % (95 %CI 9 % – 28.3 %) [76, 77] 3 – 10 patients

AC, adenocarcinoma; HGD, high-grade dysplasia. * Numbers of patients who experienced a change of diagnosis to adenocarcinoma (after a second endoscopy or after surgery) among the three patients with high-grade dysplasia identified during surveillance.

Table **3** Surgical staging of oesophageal adenocarcinoma at the time of diagnosis in surveillance and non-surveillance group patients. The data were calculated from the studies in references 51, 68 and 76

	Surveillance group n = 4	***Non-surveillance group n = 16–61***
Stage 0	37.5% (95%CI 19.6%–59.2%) 2 patients	1.3% (95%CI 0.07%–7.9%) 0–1 patients
Stage I	20.8% (95%CI 7.9%–42.7%) 1 patient	11.5% (95%CI 5.7%–21.3%) 2–7 patients
Stage IIA	20.8% (95%CI 7.9%–42.7%) 1 patient	21.8% (95%CI 13.6%–32.9%) 3–13 patients
Stage IIB	4.2% (95% CI 0.2%–23.1%) 0 patients	16.7% (95%CI 9.5%–27.2%) 3–10 patients
Stage III	16.7% (95%CI 5.5%–38.2%) 1 patient	34.6% (95%CI 24.4%–46.3%) 6–21 patients
Stage IV	0% 0 patients	14.1% (95%CI 7.6%–24.3%) 2–9 patients
Lymph node (–)	87.9% (95%CI 70.9%–96%) 4 patients	41.2% (95%CI 30.8%–52.4%) 7–25 patients

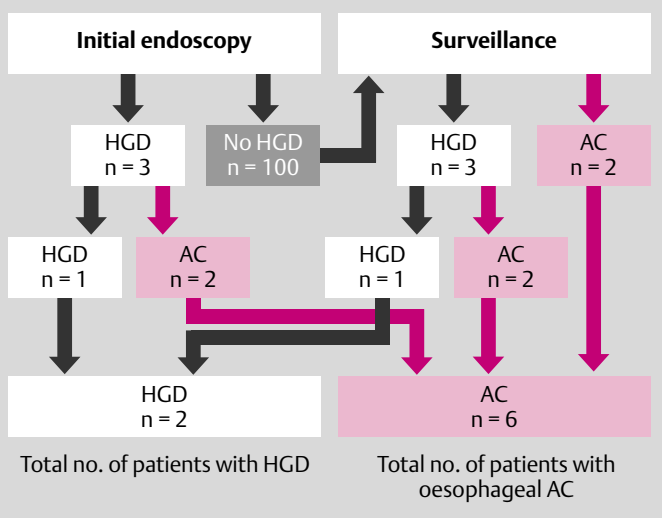

Figure **2** Overall outcome for the 103 patients who were considered eligible for surveillance (AC, adenocarcinoma; HGD, high-grade dysplasia).

Table **4** Sensitivity analysis results, expressed as percentage rates and 95% confidence intervals (95%CI)

Sensitivity	87.5% (95%CI 79.8%–92.8%)
Specificity	7.5% (95%CI 6.8%–8.2%)
False-positive rate	92.5% (95%CI 91.8%–93.2%)
False-negative rate	17% (95%CI 7.3%–20.4%)
Positive predictive value	1.9% (95%CI 1.8%–2.3%)
Negative predictive value	96.7% (95%CI 94.4%–98.1%)

In developing a surveillance strategy for people with Barrett's oesophagus, one needs to remain mindful of several issues. Firstly, gastro-oesophageal reflux is extremely common; any attempt at universal endoscopy in people with reflux disease would overwhelm the resources of any economy. Secondly, although many studies have shown that the risk of developing oesophageal adenocarcinoma is much higher in people with Barrett's oesophagus than it is in the general population [37], only a fraction of patients with Barrett's oesophagus will develop cancer [32,80,82]. Our findings bear this out: of our cohort of 103 men over the age of 50 who had Barrett's oesophagus, six were ultimately diagnosed with cancer and two with high-grade dysplasia but without cancer (Figure **2**). Indeed, in two of these patients, this was detected at the index endoscopy and not during surveillance. One cannot assume that they too would have enjoyed the optimistic prognosis of a patient whose disease was detected at surveillance. It must also be borne in mind that some studies have reported an even lower incidence of adenocarcinoma in Barrett's [7,28]. Thirdly, although surveillance programmes have become routine in some clinical practices, no direct evidence exists to support this approach. Instead, benefits from this strategy are inferred based on available indirect evidence [81]. Fourthly, any strategy must bear in mind the risks, in terms of both mortality and morbidity, attendant on that approach. For the purposes of this exercise we accepted and applied the low mortality and morbidity rates for oesophagectomy that were reported in the literature, even though these may not be reproduced in the community. Lastly, it is evident that oesophageal adenocarcinoma, despite concerns regarding its relative increase in incidence, remains a relatively rare cause of death in general. Even among patients with Barrett's oesophagus, adenocarcinoma accounted for fewer than 5% of all deaths in one recent study [82].

The cohort that we used as our model consisted of men who were aged over 50 with Barrett's oesophagus, a readily identifiable group that is widely regarded as being at greater risk of developing oesophageal adenocarcinoma. Recent studies support this choice. In an interesting prospective study, Murray et al. [33] reported that 19/789 men with Barrett's oesophagus who were aged between 50 and 60 developed oesophageal adenocarcinoma (2.4%), in contrast to only 1/243 of men with Barrett's oesophagus who were under 50 (0.4%). Furthermore, oesophageal adenocarcinoma was diagnosed in only 6/638 women with Barrett's oesophagus (0.9%). The sensitivity analysis supports this view – if an individual is in a surveillance programme, adenocarcinoma will be detected. However, it must be stressed that the sensitivity analysis applied only to those who were surveyed; most do not get that far.

Why, then, did our strategy fail so patently? The simple answer is that this strategy failed to identify the vast majority of instances of adenocarcinoma of the oesophagus. Furthermore, those patients we missed had more advanced tumours at the time of diagnosis and were unlikely to survive. Thus, while retrospective studies of patients with Barrett's oesophagus have suggested that incident cancers detected during surveillance will be discovered at an earlier stage and that the patients with these tumours will enjoy a better survival rate [51,68,76], the absolute number of such incident cancers pales into insignificance in comparison with the number of patients who develop advanced cancers without surveillance. While surveillance-detected cancer was associated with early-stage disease and much improved survival in our hypothetical cohort, the net gain in terms of lives saved was only two and, meanwhile, between 10 and 38 lives were

lost among the unscreened cohort. Others have also cautioned against an over-optimistic interpretation of survival rates for patients with surveillance-detected cancer, citing the effects of lead-time bias [83].

Compliance, adequate tissue sampling, and histological interpretation are important issues which all have an impact on the effectiveness of any surveillance programme. Only 52 of our 100 hypothetical patients with Barrett's oesophagus but without high-grade dysplasia would have been compliant. Physician compliance may also be an issue: in one recent report it was concluded that 63% of all surveillance procedures had been performed following medical review rather than as a result of a planned strategy [84]. The most widely practised biopsy protocol for surveillance recommends taking quadrantic biopsies every 2 cm within the Barrett's segment. However, surprisingly, a recent retrospective audit found that most endoscopists were not following biopsy guidelines; the recommended numbers of biopsies were submitted from only 40% of all patients with Barrett's oesophagus [84]. Inter-observer and intra-observer errors in the interpretation of dysplasia are further confounding variables: in one study, for example, the average agreement rate between pathologists for low-grade dysplasia was found to be only 64.7% (95%CI 38.6% – 84.7%) [45]. We assumed a best-case scenario with regard to patient and endoscopist compliance within a surveillance strategy, an approach which should have over-estimated rather than under-estimated the impact of the strategy.

Oesophagectomy, currently the definitive therapeutic option for the patient with cancer or high-grade dysplasia, remains a technically demanding surgical procedure which is associated with significant morbidity and mortality. Evidence is accumulating to indicate that results are considerably better in facilities where this procedure is performed more frequently [85 – 87]. It has been suggested that the performance of oesophagectomy for malignancy should be restricted to hospitals where this operation is performed at a minimum rate of six cases per year [85]. Although no patient died as a result of surgery in our surveillance strategy group, between one and three of the 16 – 61 patients presenting de novo would have died as a consequence of their surgical procedure. Furthermore, rates of 6.7% for major complications and 21.6% for minor complications would be expected. Surgery is therefore a daunting prospect. Whether other less invasive endoscopic approaches will reduce morbidity, while providing definitive cure, remains to be seen.

It should come as no surprise, therefore, that various studies have failed to provide evidence that surveillance programmes in patients with Barrett's oesophagus are cost-effective, even when assuming a best-case scenario [88 – 92]. For example, Inadomi et al. [92] reported that a surveillance programme for patients with Barrett's oesophagus without dysplasia, even when performed at 5-yearly intervals, proved to be a very expensive undertaking. Putting it simply, most patients in any surveillance programme will not experience progression of their disease – our sensitivity analysis supports this, as indicated by the very low specificity and positive predictive values.

For now, at least, the concept of risk stratification for oesophageal adenocarcinoma continues to remain elusive. Gender (male), ethnicity (white), age (over 50), duration of symptoms (more than 5 years), the presence of complications of reflux, and the definition of high-grade dysplasia have all been identified as risk factors for Barrett's oesophagus and oesophageal adenocarcinoma [2,11,93]. However, there is no convincing evidence that screening and surveillance programmes based on any one or on a combination of these risk factors prevents death from cancer. Studies have reported that biomarkers such as abnormal flow cytometry, cyclin D1 over-expression, loss of heterozygosity of p53, and high-mobility group protein (HMGI(Y)) expression may correlate with the future development of adenocarcinoma and may potentially be used to risk-stratify patients with Barrett's oesophagus [94]. However, because all the studies on these markers have, to date, included only a relatively small number of patients, confirmation of their effectiveness as risk factors in larger studies and with longer follow-up is warranted. Although optical coherence tomography is not yet ready for application in clinical practice, studies have shown that this technique may become a useful tool in the surveillance of Barrett's oesophagus [95].

We readily acknowledge the limitations of our approach. Our secondary analysis is only as good as the original data on which it was based. Variations in study size, age and gender distribution of the population studied, compliance, extent of follow-up and nature of the follow-up protocol, as well as the completeness of the data, all limit the interpretability of the data and, therefore, of our conclusions. In many instances, the size of subgroups was insufficient to perform meaningful subgroup analysis and many studies did not provide variables, such as age, as a continuous variable, thus precluding our ability to develop optimal thresholds for a surveillance strategy. Furthermore, there continues to be a distinct paucity of data on the true natural history of Barrett's oesophagus in the community.

In conclusion, surveillance programmes for patients with Barrett's oesophagus, based on current approaches to risk stratification, cannot have any substantial impact on morbidity and mortality from oesophageal adenocarcinoma as they target only a minority of those patients who eventually develop this form of cancer. Better approaches to risk stratification are required before a Barrett's surveillance programme can be implemented.

Acknowledgements

Eamonn M. M. Quigley is supported by grants from Science Foundation Ireland (SFI). Rodrigo Quera was supported by a research fellowship in gastroenterology from University College Cork, Ireland at the time of this work. This work was first presented as an oral presentation at the Spring Meeting of the Irish Society of Gastroenterology in June 2004 in Kilkenny, Ireland. The authors have no conflicts of interest with respect to this work, and the funding sources had no role in the preparation of this manuscript.

In Brief

A literature analysis, summarizing evidence from 31 papers on different aspects of Barrett's esophagus and then formulating a hypothetical model – an interesting method involving a kind of practical meta-analysis. Due to the insufficient identification of Barrett's patients and high-risk patients, surveillance was found to be unlikely to affect mortality - mainly due to the occurrence of cancers in patients not receiving surveillance.

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