

# Assessment of the role of the Edinburgh dysphagia score in referral triage in a national service evaluation of the urgent suspected upper gastrointestinal cancer pathway

Kamran, Umair; King, Dominic; Banks, Matthew; Nylander, David ; Shetty, Sharan ; Hebbar, Srisha; Ransford, Rupert ; Mitchell, David ; Williams, Matthew ; Gupta, Sanjay ; Cheung, Danny; Baker, Graham; Rees, James; Fox, Mark ; Ashall, Barbara ; Barker, Sophie ; Greenaway, John ; Jones, Miriam ; Caffrey, Matthew ; Kadri, Sudarshan

DOI:  
[10.1111/apt.16811](https://doi.org/10.1111/apt.16811)

License:  
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Document Version  
Peer reviewed version

## Citation for published version (Harvard):

Kamran, U, King, D, Banks, M, Nylander, D, Shetty, S, Hebbar, S, Ransford, R, Mitchell, D, Williams, M, Gupta, S, Cheung, D, Baker, G, Rees, J, Fox, M, Ashall, B, Barker, S, Greenaway, J, Jones, M, Caffrey, M, Kadri, S, Glynn, M, Tham, TC, Adderley, N, Trudgill, N & Evans, J 2022, 'Assessment of the role of the Edinburgh dysphagia score in referral triage in a national service evaluation of the urgent suspected upper gastrointestinal cancer pathway', *Alimentary Pharmacology & Therapeutics*. <https://doi.org/10.1111/apt.16811>

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1 **Assessment of the role of the Edinburgh dysphagia score in referral**  
2 **trriage in a national service evaluation of the urgent suspected upper**  
3 **gastrointestinal cancer pathway.**

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57  
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59 **Group name**

60  
61 Upper GI cancer two week wait study group

62

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67

68 **Funding declaration**

69 Nothing to declare.

70 **Conflicts of Interests:**

71 No conflict of interest.

72 **Author contributions:**

73 Study concept and design was jointly conceived by UK, DK and NT. All co-authors participated in  
74 data collection. UK and NA analysed the data. UK and NT drafted manuscript and it was critically  
75 revised and approved by all authors.

76

77

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91

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93 and transparent account of the study being reported; that no important aspects of the study have  
94 been omitted; and that any discrepancies from the study as originally planned (and, if relevant,  
95 registered) have been explained.

96

## 97 **Word count**

98 Main document 2720

99

100 **Summary**

101

102 **Background**

103 The British Society of Gastroenterology has recommended the Edinburgh Dysphagia Score (EDS)  
104 to risk stratify dysphagia referrals during the endoscopy COVID recovery phase.

105

106 **Aims**

107 External validation of the diagnostic accuracy of EDS and exploration of potential changes to  
108 improve its diagnostic performance.

109

110 **Methods**

111 A prospective multicentre study of consecutive patients referred with dysphagia on an urgent  
112 suspected upper gastrointestinal (UGI) cancer pathway between May 2020 and February 2021.  
113 The sensitivity and negative predictive value (NPV) of EDS were calculated. Variables associated  
114 with UGI cancer were identified by forward stepwise logistic regression and a modified Cancer  
115 Dysphagia Score (CDS) developed.

116

117 **Results**

118 1301 patients were included from 19 endoscopy providers; 43% male; median age 62(IQR 51-73)  
119 years. 91(7%) UGI cancers were diagnosed, including 80 oesophageal, 10 gastric and one  
120 duodenal cancer. An EDS  $\geq 3.5$  had a sensitivity of 96.7(95% CI 90.7-99.3)% and a NPV of  
121 99.3(97.8-99.8)%. Age, male sex, progressive dysphagia and unintentional weight loss  $>3\text{kg}$  were  
122 positively associated and acid reflux and localisation to the neck were negatively associated with  
123 UGI cancer. Dysphagia duration  $<6$  months utilised in EDS was replaced with progressive  
124 dysphagia in CDS. CDS  $\geq 5.5$  had a sensitivity of 97.8(92.3-99.7)% and NPV of 99.5(98.1-99.9)%.  
125 Area under receiver operating curve was 0.83 for CDS, compared to 0.81 for EDS.

126

127 **Conclusions**

128 In a national cohort, the EDS has high sensitivity and NPV as a triage tool for UGI cancer. The CDS  
129 offers even higher diagnostic accuracy. The EDS or CDS should be incorporated into urgent  
130 suspected UGI cancer pathway.

131

132

## 133 **Introduction**

134

135 Around 16,000 patients are diagnosed with upper gastrointestinal (UGI) cancer each year in the  
136 UK.[1,2] UGI cancer often has a poor prognosis with only 17% and 21% surviving for 5 years after  
137 an oesophageal and gastric cancer diagnosis respectively.[3] In the UK, patients suspected of  
138 having UGI cancer are referred on an urgent suspected cancer two week wait (2WW) pathway,  
139 direct to endoscopy or an outpatient clinic. In 2018/19, 190,000 patients were referred on the  
140 UGI 2WW pathway in the UK[4], but only 3% were actually diagnosed with cancer.[5] Dysphagia  
141 is an important predictor of UGI cancer[6,7] and the National Institute for Health and Care  
142 Excellence (NICE) in the UK recommends that direct, open access UGI endoscopy should be  
143 offered to all patients with dysphagia within two weeks.[8] However, it has been reported that  
144 up to 15% of patients referred with dysphagia in the UK do not have actual difficulty swallowing  
145 and less than 10% are diagnosed with UGI cancer.[9] This results in significant pressures on  
146 endoscopy services to achieve these national waiting time targets and may delay UGI cancer  
147 diagnosis in patients investigated outside the 2WW pathway.

148

149 During the first wave of the COVID-19 pandemic in the UK in April 2019, the British Society of  
150 Gastroenterology (BSG) recommended that all 2WW referrals should be triaged by senior  
151 clinicians and the Edinburgh dysphagia score (EDS) used to prioritise patients with dysphagia for  
152 urgent endoscopy.[5] The EDS was devised in 2010 for risk stratification of patients with  
153 symptoms of dysphagia, with those with an EDS  $\geq 3.5$  at higher risk of oesophageal cancer.[10]  
154 Predictors of oesophageal cancer included age, sex, unintentional weight loss > 3kg, localisation  
155 to the neck, duration of symptoms and reflux symptoms. The EDS was further validated in a single  
156 centre study of 1775 patients and reported to have a sensitivity of 98.4% and negative predictive  
157 value of 98.0%.[11]

158

159 We conducted a national service evaluation of the UGI cancer 2WW referral pathway during the  
160 recovery phase of COVID-19 and prospectively validated EDS performance in a cohort of patients  
161 referred with dysphagia.



## 162 **Methodology**

163

### 164 **Study population and data collection**

165 This study included consecutive adult patients referred with symptoms of dysphagia on a 2WW  
166 UGI cancer pathway, to the 19 participating providers across the UK, between May 2020 and  
167 February 2021. All referrals were triaged on the telephone by consultant gastroenterologists,  
168 consultant UGI surgeons, nurse endoscopists or clinical nurse specialists in UGI cancer or  
169 endoscopy. A standardised anonymised data collection tool on a Microsoft Excel spreadsheet  
170 was used by all providers, which allowed automatic calculation of the EDS and included a decision  
171 aid to guide prioritisation of endoscopy or alternate investigations if no endoscopy capacity,  
172 based on the BSG recovery document.[5] Data on additional clinically relevant variables identified  
173 from a literature search were also collected.[11,12] Variables included patient demographics  
174 (age, sex, smoking status), symptoms (dysphagia or odynophagia, duration of dysphagia >6  
175 months, localisation of dysphagia to neck, progressive or intermittent symptoms of dysphagia,  
176 unintentional weight loss >3kg and reflux symptoms). **Data on** triage decision details and  
177 investigation results was also recorded.

178

179 Referrals were triaged to one of the following pathways: EDS  $\geq 3.5$ - 2WW endoscopy; EDS < 3.5  
180 and patient age >55 years- urgent (non 2WW) endoscopy; EDS < 3.5 and patient age <55 years-  
181 routine endoscopy; and no investigation if no true dysphagia or other indication for  
182 investigations. Alternative investigations included CT scan and barium swallow.

183

184 Exclusion criteria included: patients not referred with symptoms of dysphagia, if investigations  
185 were declined by patients, if patients were not fit for any investigation, if patients did not have  
186 true dysphagia or other symptoms worthy investigation, if investigation results not available on  
187 28th February 2021 and if a non-UGI cancer was diagnosed.

188

### 189 **Aims**

190 The primary aims of this study were to validate the diagnostic accuracy of EDS and to assess if  
191 any amendments could potentially improve its diagnostic performance, using patient variables  
192 associated with UGI cancer.

193

#### 194 **Statistical analysis and development of cancer dysphagia score**

195 Statistical analysis was performed using *Stata Statistical Software Release 16: StataCorpLLC*.  
196 Categorical variables were summarised as number and percentages and continuous variables as  
197 median and interquartile range (IQR). The  $\chi^2$  test was used to compare categorical variables and  
198 the t-test or nonparametric test (Mann-Whitney U) were used to compare continuous variables  
199 as appropriate. The sensitivity, specificity, positive predictive value (PPV) and negative predictive  
200 value (NPV) of EDS at a cut off of  $\geq 3.5$  were calculated.

201

202 Univariable and multivariable logistic regression models explored the association of study  
203 variables with an UGI cancer diagnosis. The dependent variable was the occurrence of UGI cancer  
204 and the exploratory variables included age as a continuous variable and sex, unintentional weight  
205 loss  $>3\text{kg}$ , localisation of dysphagia to neck, progressive dysphagia, presence of reflux symptoms,  
206 history of smoking and duration of symptoms of  $<6\text{months}$  as categorical variables. The variables  
207 with statistical significance on univariate analysis were included in multivariable analysis. Missing  
208 data were treated as complete case analysis and any observation with a missing value for the  
209 variable of interest was excluded and only complete observations were included in the logistic  
210 regression analysis.

211

212 To develop a modified prediction model, candidate variables were selected using a forward  
213 stepwise regression approach. Forward stepwise regression is a method of fitting regression  
214 models in which the choice of predictive variables is carried out by an automatic procedure.  
215 Starting with no variables in the model, the addition of each variable using a chosen model fit  
216 criterion ( $p < 0.1$ ) is tested, adding the variable whose inclusion gives the most statistically  
217 significant improvement of the fit, and repeating this process until none improves the model to  
218 a statistically significant extent. The model was internally validated by bootstrap resampling,

219 which used 1000 random samples drawn with replacement from the original dataset.[13,14]  
220 Regression coefficients of the selected variables from multivariable logistic regression analysis  
221 were used to develop a scoring system following the methodology described by Sullivan et al.[15]  
222 and explained in supplementary material 1.

223  
224 Receiver operating characteristic (ROC) curves were produced for both the EDS and the modified  
225 prediction model and the discriminative ability of both models was compared using the area  
226 under receiver operating curve (AUC), equivalent to c-statistics. Calibration plots were produced  
227 to examine the performance of the models, displaying observed probability by deciles of  
228 predicted probability. LOWESS (Locally weighted scatterplot smoothing) function was used to  
229 create a smooth line through the scatter plot to display relationship between expected and  
230 observed probabilities and foresee trends. Calibration slope gradient and calibration in the large  
231 (CITL) were reported. Calibration slope close to 1 and CITL close to 0 represent good calibration.

232  
233 **Subgroup analyses were performed to compare the sensitivity of both scoring systems at age cut**  
234 **offs of 70 and 60 years.**

235  
236 **Patient and public involvement**

237 There was no patient and public involvement in this study.

238  
239 **Ethics**

240 As determined by the national decision-making tool of the NHS Health Research Authority and  
241 the Medical Research Council, this study was part of a service evaluation and did not require  
242 ethics committee approval. Each participating provider attained local institutional approval prior  
243 to data collection.

244

## 245 **Results**

### 246 **Study subjects**

247 A total of 1301 patients were included from 19 providers across the UK. A flow chart of the  
248 patients included in the study is shown in Figure 1. 69% (n=910) of patients were triaged to 2WW  
249 endoscopy, 20% (n=257) to urgent (non 2WW) endoscopy, 5% (n=66) to routine endoscopy, 2%  
250 (n=25) to CT scan and 3% (n=43) to barium swallow.

251  
252 91 (7%) patients were diagnosed with UGI cancer, including 80 oesophageal, 10 gastric and one  
253 duodenal cancer. Prevalence of UGI cancer in the patients triaged to 2WW endoscopy and urgent  
254 (non 2WW) endoscopy was 9.2% and 2.3% respectively. One cancer was diagnosed in patients  
255 triaged to Barium swallow (2.3%) and no UGI cancer was diagnosed in patients triaged to routine  
256 endoscopy or CT scan. The baseline characteristics and the symptoms of patients with and  
257 without an UGI cancer diagnosis are shown in Table 1. Patients with UGI cancer were more  
258 commonly male and reported more often progressive symptoms, a history of unintentional  
259 weight loss, less commonly had symptoms localised to the neck or reflux symptoms and had a  
260 higher median EDS.

261

### 262 **The diagnostic accuracy of the Edinburgh Dysphagia Score**

263 An EDS  $\geq 3.5$  had a sensitivity of 96.7(95% CI 90.7-99.3)%, a specificity of 32.6(30.0-35.4)%, a PPV  
264 of 9.7(7.9-11.9)% and a NPV of 99.3(97.8-99.8)%. 3(3%) UGI cancers were diagnosed in patients  
265 with an EDS  $< 3.5$  (one gastric cancer with EDS 2.5, two oesophageal cancers with EDS 1.5). The  
266 AUC for EDS was 0.81(0.76-0.85).

267

### 268 **Univariable and multivariable logistic regression analysis of factors associated with** 269 **UGI cancer and development of a new Cancer Dysphagia Score**

270 The results of univariable and multivariable regression analysis of factors associated with UGI  
271 cancer are shown in Table 2. Increasing age, sex, unintentional weight loss  $> 3$ kg, localisation of  
272 dysphagia to neck, progressive symptoms and reflux symptoms were associated with UGI cancer  
273 and retained in the prediction model. However, duration of dysphagia  $< 6$  months and history of  
274 smoking were excluded in forward stepwise selection regression analysis. Weighted points were

275 assigned proportional to the regression coefficient values of selected variables to develop the  
276 cancer dysphagia score (CDS), as explained in supplementary material 1. This had strong  
277 discriminative ability on internal validation, as measured by AUC (0.83(95% CI 0.79-0.87)).

278  
279 A CDS cut off of  $\geq 5.5$  had a sensitivity of 97.8(92.3-99.7)%, a specificity of 31.2(28.7-34.0)%, a PPV  
280 of 9.7(7.8-11.8)% and NPV of 99.5(98.1-99.9)%. Two (2.2%) oesophageal cancers were diagnosed  
281 in patients with a CDS  $< 5.5$ . Both patients were female (age  $< 50$  years) and presented with more  
282 than 6 months history of dysphagia without weight loss (CDS 2.0). One patient had associated  
283 symptoms of chest pain. Both were triaged to urgent endoscopy which was performed within a  
284 month of triage.

285  
286 **Comparison between the Edinburgh Dysphagia Score and the Cancer Dysphagia Score**

287 The variables and points allocated to each of the risk categories for both EDS and CDS are  
288 presented in Table 3 and a comparison of the ROC curves and AUC is shown in Figure 2. The AUC  
289 for the CDS (0.829) is higher than the AUC for EDS (0.805). Calibration plots are presented in  
290 Figure 3. Slope gradients of 1.00 and CITL of 0.00 represent excellent performance for both  
291 models. When applied to the overall cohort, the prevalence of UGI cancer in high and low risk  
292 categories based on the CDS and EDS is shown in Table 4. The CDS is more sensitive than the EDS  
293 with less cancers in the low risk group, but this difference is only based on one UGI cancer that is  
294 high risk on the CDS but low risk on the EDS.

295  
296 On subgroup analyses, sensitivity and NPV of CDS  $\geq 5.5$  and EDS  $\geq 3.5$  were 100% at the age cut  
297 off  $\geq 70$  years. However, CDS was more sensitive than EDS in identifying UGI cancer patients in  
298 those less than 70 years of age (CDS 94.59% vs EDS 91.89%) and in those less than 60 years of  
299 age (CDS 86.67% vs EDS 80%).

300

## 301 Discussion

302

303 Given the relatively low diagnostic yield (3%) of the current 2WW UGI cancer referral pathway in  
304 the UK and the pressures on endoscopy units given the COVID 19 pandemic and addressing  
305 consequent waiting issues, the availability of an effective triage tool will be of great value in  
306 prioritising patients for endoscopy. In this multicentre, prospective study, we have shown that  
307 the EDS and the updated CDS are just such triage tools with very high sensitivities and negative  
308 predictive values. Applying the CDS to the 2WW referral population studied, up to 30% of  
309 dysphagia referrals could have been safely investigated more routinely.

310

311 The EDS was initially developed to triage patients with dysphagia into high and low risk  
312 groups.[10] The prevalence of cancer in this study was 10% and 14% in the derivation and  
313 validation cohorts, respectively, and the AUC for the EDS was reported to be 0.70 in the validation  
314 cohort. However, this study had a number of limitations including a relatively small sample size,  
315 being from a single provider and retrospective. Finally, data were extracted from the primary  
316 care referral forms for both the derivation and validation of the EDS rather than from direct  
317 contact with the patient. An audit of dysphagia referrals to a district general hospital reported  
318 that up to 15% of patients referred on a cancer pathway did not have true dysphagia and relying  
319 on data from referral forms may therefore have limitations.[9] The present study is the largest  
320 prospective multicentre study of the EDS in 2WW referrals. Senior clinicians collected  
321 information directly from patients using a structured data collection tool during telephone triage.  
322 5% of patients referred on the 2WW pathway did not have true swallowing difficulties or had a  
323 brief episode with spontaneous resolution of symptoms and hence did not require any  
324 investigation. Unlike the study that developed EDS[10], in the present study the duration of  
325 symptoms was not found to be associated with UGI cancer, and a strong positive association was  
326 found between UGI and progressive dysphagia. A single provider study of 2000 patients with  
327 dysphagia has also reported a positive association of progressive symptoms with UGI cancer [11].  
328 Progressive dysphagia increased the odds of having UGI cancer more than two-fold and was  
329 therefore selected as a predictor in the updated CDS. The AUC for the CDS was 0.83 (compared  
330 to 0.81 for the EDS), with small improvements in sensitivity and NPV compared with EDS.

331 According to NICE recommendations in the UK, 2WW endoscopy should be offered to patients  
332 of any age over 18 referred with dysphagia to exclude cancer.[8] However, dysphagia is a  
333 common symptom in the community with a prevalence of up to 16% in the general  
334 population[16,17], and despite it being considered an important “alarm” feature, only 2%-8% of  
335 those referred with dysphagia for investigation are diagnosed with UGI cancer.[18–20] We found  
336 that the CDS, at a threshold of  $\geq 5.5$ , clearly identified a much higher risk group of patients with  
337 dysphagia with a prevalence of UGI cancer of 9.7%. **Although both CDS and EDS were highly**  
338 **sensitive to detect UGI cancers in elderly patients over 70 years of age, the sensitivity of CDS was**  
339 **higher in identifying the higher risk patients in younger age groups. However,** two female patients  
340 (age <50 years) were mis-categorised as low risk by both CDS and EDS and were found to have  
341 oesophageal cancer. It is important that although high risk patients with EDS  $\geq 3.5$  (or CDS  $\geq 5.5$ )  
342 as a smaller cohort with a higher prevalence of cancer can be investigated more urgently within  
343 two weeks, as recommended by the BSG and NHS England, patients at lower risk (but not zero  
344 risk) of UGI cancer are safety netted in primary care and their investigation pathway should be  
345 reviewed if their symptoms and CDS get worse.[21]

346

347 **Although urgent investigation pathways for dysphagia are focused on cancer detection, there are**  
348 **important non-malignant causes of dysphagia including eosinophilic oesophagitis, benign**  
349 **oesophageal strictures and achalasia, which can have a major impact on patients’ quality of life.**  
350 **Although effective treatments are available for these conditions, such patients may not be**  
351 **categorised as higher risk on risk stratification systems and there is a risk of delayed diagnoses**  
352 **for those not investigated on an urgent pathway.**

353

354 This study has a number of limitations. The absence of long term follow up data limited the ability  
355 to assess the outcomes for a small number of patients (5%) who were triaged to no investigations  
356 due to the absence of true dysphagia or a brief episode of symptoms which had spontaneously  
357 resolved. During the pandemic it was not possible to endoscope such patients with clinically an  
358 extremely low risk of UGI cancer. These patients were consequently excluded from the analysis  
359 but it is possible that some might have re-presented with similar symptoms at a later date and

360 been diagnosed with UGI cancer. Although a standardised data collection tool was used to  
361 prospectively collect information, clinical judgment was required to interpret the information  
362 provided on the telephone by the patient bringing a risk of information or measurement bias.  
363 Progressive dysphagia was found to be a predictor of UGI cancer and was used in the  
364 development of the CDS, but this information was based on a patient's perception of worsening  
365 in their swallowing since the start of their symptoms, rather than a functional grading system to  
366 assess the severity of dysphagia. We suggest that future studies should consider using a validated  
367 dysphagia grading system for consistency in the interpretation of progressive dysphagia. The data  
368 for this study was collected directly from the patients by experienced clinicians over the  
369 telephone. This was an important process to prioritise scarce endoscopy resources during the  
370 first wave of the COVID 19 pandemic in the UK.[5] It has not been possible in UK hospitals to  
371 continue to provide the clinical time for telephone triage of all 2WW referrals, given the partial  
372 recovery of endoscopy services and competing demands on clinical time. There are still  
373 considerable endoscopy diagnostic backlogs due to COVID throughout the UK and resource  
374 prioritisation is still important. It has been proposed that the EDS is used by primary care  
375 practitioners in England to prioritise referrals with dysphagia [21]. However, as previously noted,  
376 primary care practitioners may be less able to accurately recognise dysphagia and other  
377 symptoms as experienced gastroenterological clinicians [9] and the EDS or CDS should be studied  
378 when utilised in primary care prior to referral for endoscopy to ensure it performs as well in this  
379 setting as it does in secondary care telephone triage. This study was carried out during the  
380 COVID19 pandemic and it is possible that primary care practitioners had a lower threshold for  
381 referral on the 2WW pathway, given difficulty accessing secondary care opinions through other  
382 routes. However, the overall cancer rate was 7% and this is similar to historic cancer rates for  
383 2WW UGI cancer referrals.[22] Finally, although the CDS showed a high sensitivity and  
384 discriminative ability on internal validation, it has not been externally validated.

385

## 386 **Conclusion**

387 In a multi-centre prospective evaluation of patients referred on an urgent cancer pathway from  
388 primary care with dysphagia, the EDS had a high sensitivity and NPV as a triage tool for UGI



389 cancer. The sensitivity and NPV can be improved further in the CDS. The CDS or EDS should be  
390 incorporated into the 2WW UGI cancer pathway to prioritise those at highest risk of cancer.

391

### 392 **Acknowledgement**

393 We are grateful to the Clinical Services and Standards Committee of the BSG for their support  
394 and help promoting this service evaluation. We are also grateful to Sara Brogden (Lead Non-  
395 medical Endoscopist, University College London Hospitals NHS Foundation Trust, United  
396 Kingdom), Samantha Horley (Endoscopy Nurse Practitioner, The Dudley Group NHS Foundation  
397 Trust, United Kingdom), Suzanne Friday (Advanced Nurse Practitioner, Upper Gastrointestinal  
398 Cancer Nurse, Croydon Health Services NHS Trust, United Kingdom) and Tracey Noakes (Upper  
399 Gastrointestinal Cancer Nurse Specialist, James Paget University Hospitals NHS Foundation  
400 Trust, United Kingdom) for their help in data collection.

401

### 402 **Funding declaration**

403 Nothing to declare.

404

405

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469

470 **Tables**

471

472 **Table 1 The demographic details and symptoms at triage of study patients, stratified**473 **by a diagnosis of upper gastrointestinal cancer**

474

<b>Variables</b>	<b>Total</b>	<b>Non-UGI cancer cohort</b>	<b>UGI cancer cohort</b>	<b>P-value</b>
Number	1301	1210	91	
Age, median (IQR)	62 (51, 73)	62 (51, 73)	71 (61, 76)	<0.001
Male	554 (42.7%)	488 (40.4%)	66 (72.5%)	<0.001
History of smoking*	437 (34.9%)	399 (34.3%)	38 (42.7%)	0.11
Duration of dysphagia <6 months	908 (69.8%)	843 (69.7%)	65 (71.4%)	0.72
Dysphagia localised to neck	314 (24.1%)	305 (25.2%)	9 (9.9%)	<0.001
Progressive dysphagia**	577 (45.6%)	519 (44.1%)	58 (66.7%)	<0.001
Unintentional weight loss >3kg	377 (29.0%)	323 (26.8%)	54 (59.3%)	<0.001
Reflux symptoms	407 (31.3%)	391 (32.3%)	16 (17.6%)	0.003
Other associated symptoms				
Abdominal mass	2 (0.2%)	2 (0.2%)	0 (0.0%)	0.12

Chest pain	45 (3.5%)	38 (3.1%)	7 (7.7%)	
Dyspepsia	643 (49.4%)	603 (49.8%)	40 (43.4%)	
Globus	38 (2.9%)	38 (3.1%)	0 (0.0%)	
Haematemesis/melaena	4 (0.3%)	4 (0.3%)	0 (0.0%)	
Throat clearing/cough	17 (1.3%)	15 (1.2%)	2 (2.2%)	
EDS score	5 (3-6)	4 (2.5-6)	7 (6-8)	<0.001

475

476 \*Data not available for 49 patients.

477 \*\*Data not available for 30 patients.

478 UGI: upper gastrointestinal cancer, EDS: Edinburgh Dysphagia Score, IQR: Interquartile range.

479

480 **Table 2 Univariable and multivariable logistic regression analysis of factors**  
 481 **associated with a diagnosis of upper gastrointestinal cancer.**

482

<b>Variables</b>	<b>Unadjusted OR (95% CI)</b>	<b>Adjusted OR (95% CI)</b>	<b>P-value*</b>	<b>Regression coefficients</b>
Age	1.05 (1.03-1.06)	1.05 (1.03-1.06)	<0.001	0.04
Male	3.89 (2.42-6.25)	3.95 (2.36-6.58)	<0.001	1.40
History of smoking	1.43 (0.92-2.20)			
Unintentional weight loss >3kg	3.99 (2.58-6.19)	3.28 (2.02-5.31)	<0.001	1.22
Dysphagia localised to neck	0.33 (0.16-0.66)	0.26 (0.12-0.57)	0.001	-1.40
Duration of dysphagia <6 months	1.09 (0.68-1.75)			
Progressive dysphagia	2.54 (1.60-4.02)	2.30 (1.39-3.79)	0.001	0.83
Reflux	0.45 (0.26-0.78)	0.47 (0.25-0.88)	0.018	-0.73

483

484 49 subjects were excluded from the regression analyses due to missing data.

485 \*p value of adjusted odds ratio.

486 OR: odds ratio; CI: confidence interval.

487

488 **Table 3 Variables and the points allocated to each of the risk category in Edinburgh**  
 489 **Dysphagia Score and Cancer Dysphagia Score.**

490

<b>Variables</b>	<b>Edinburgh Dysphagia Score</b>	<b>Cancer Dysphagia Score</b>
<b>Age (years)</b>		
<39	0	0
40-49	4	2
50-59	5	4
60-69	6	6
70-79	7	8
80-89	8	10
90-99	9	12
<b>Sex</b>		
Female	-1	0
Male	0	6
<b>Unintentional weight loss &gt;3kg</b>		
No	0	0
Yes	2	5.5
<b>Duration of symptoms ≥ 6 months</b>		
No	0	Not included
Yes	-1.5	
<b>Localisation of dysphagia to neck</b>		
No	0	0
Yes	-2	-6
<b>Acid reflux symptoms</b>		
No	0	0
Yes	-1	-3
<b>Progressive dysphagia</b>		
No	Not included	0
Yes		3.5

491

492

493



494 **Table 4 The prevalence of upper gastrointestinal cancer in the high and low risk**  
 495 **categories of the Cancer Dysphagia Score and the Edinburgh Dysphagia Score.**

496

Scoring system	Risk category	Number of patients	Number of cancers	Prevalence (95% Confidence interval)
Cancer dysphagia score (CDS)	High risk (CDS $\geq 5.5$ )	920	89	9.7% (7.9-11.8)
	Low risk (CDS $< 5.5$ )	381	2	0.5% (0.1-1.8)
Edinburgh dysphagia score (EDS)	High risk (EDS $\geq 3.5$ )	903	88	9.8% (7.9-11.9)
	Low risk (EDS $< 3.5$ )	398	3	0.8% (0.2-2.2)

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502 **Figures**

503

504

505 **Figure 1 Flow chart of patients in the study.**

506 2WW: two week wait; UGI: upper gastrointestinal.

507

508

509 **Figure 2 Comparison between receiver operating curves for the Edinburgh**  
510 **Dysphagia Score and the Cancer Dysphagia Score.**

511 AUC: area under the curve, EDS: Edinburgh Dysphagia Score, CDS: Cancer Dysphagia Score

512

513

514 **Figure 3 Calibration plots for the Edinburgh Dysphagia Score and the Cancer**  
515 **Dysphagia Score.**

516 CITL: Calibration in the large, LOWESS: Locally weighted scatterplot smoothing

517

518

519 **Supplementary material 1**

520

521 **Development of a new cancer dysphagia scoring system from the multivariable**  
522 **logistic regression model**

523

524

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