

A RAND NOTE

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THE EFFECT OF COMORBIDITY ON APPROPRIATENESS RATINGS FOR TWO GASTROINTESTINAL PROCEDURES

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Abstract—We evaluated the effect of patients' comorbidity on the appropriateness of performing esophagogastroduodenoscopy or cholecystectomy. A nine-member national physician panel rated 1118 brief clinical scenarios for patients without comorbidity. Ratings were then repeated for patients with increasing degrees of comorbidity. As comorbidity changed from none to medium, 60% of those scenarios that were originally rated as appropriate for endoscopy and cholecystectomy remained appropriate. As high comorbidity was introduced, only 13% of such scenarios remained appropriate for endoscopy, while 33% remained appropriate for cholecystectomy. These findings suggest that, although clinical reasons for performing procedures are a powerful determinant of when they should be used, comorbidity is also important and needs to be included in any assessment of the appropriateness of procedure use.

INTRODUCTION

The decision whether to perform endoscopy for chronic dyspepsia may differ for a generally healthy patient and for a nonambulatory nursing home resident with endstage renal disease. The difference depends upon the patient's comorbidity: medical problems or functional limitations other than those due to the condition for which the procedure is being performed [1].

The increasing interest in the effect of comorbidity on diagnostic and therapeutic deci-

sions is due to: (1) the rising number of elderly patients who are more likely to have comorbid conditions [2, 3]; (2) the increasing cost of care for patients with comorbid conditions [4]; and (3) the realization that patient comorbidity may help explain variations in population based use rates for specific procedures [5, 6].

Although research has demonstrated a relationship between comorbidity and outcome, it has not explicitly addressed the effect of comorbidity on the appropriateness of use of procedures [7–11]. When appropriateness has been evaluated the focus has often been the reason for which a procedure is performed [12–14]. For instance, the appropriateness of performing an upper gastrointestinal endoscopy is dependent on the patient's ulcer history and that of performing coronary angiography is related to the severity of angina symptoms.

The purpose of this paper is to describe how comorbidity affected a physician panel's ratings

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of the appropriateness of using two gastrointestinal procedures: upper gastrointestinal endoscopy and cholecystectomy.

METHODS

A panel of nine expert physicians with geographic and specialty diversity rated the appropriateness of 1118 brief clinical scenarios for upper GI endoscopy ($n = 1069$) and cholecystectomy ($n = 49$) [11]. A comprehensive list of possible scenarios for each procedure was generated by physician members of the research staff after review of the medical literature. The scenarios, which described clinical reasons for performing the procedure, categorized patients according to symptoms, past medical history, and/or results of diagnostic tests. We attempted to develop scenarios that were detailed enough so that patients having the procedure under a particular scenario would be homogeneous with respect to the appropriateness of performing the procedure. In addition, we attempted to generate enough scenarios to include all possible indications for performing the procedure, while keeping the lists concise enough so that they could be rated by panelists.

Because of the large number of scenarios for endoscopy we organized them into chapters, with each chapter representing a particular clinical presentation. There were 16 clinical chapters for endoscopy (Table 1).

The panel followed a two-stage modified Delphi process. In the first stage, the panelists individually and without discussion rated the scenarios on a 9-point integer scale. Extremely appropriate scenarios were rated nine, equivocal scenarios (neither clearly appropriate nor clearly inappropriate) were rated five, and extremely inappropriate scenarios were rated one. "Appropriate" was defined to mean that the expected health benefit (i.e. increased life expectancy, relief of pain, reduction in anxiety, improved functional capacity) exceeded the expected negative consequences of performing the procedure (i.e. mortality, morbidity, anxiety of anticipating the procedure, misleading or false diagnoses, pain produced by the procedure, time lost from work) by a sufficiently wide margin that the procedure was worth doing.

Based on comments and advice from the panelists, a physician member of the research staff modified the scenarios to better reflect clinical practice. For example, scenarios were

Table 1. Clinical chapters used for forming judgments about the appropriateness of using endoscopy

Chapter name	Number of scenarios
Asymptomatic patients	54
Follow-up to prior endoscopy finding	186
Follow-up to prior upper GI series finding	63
Upper GI bleeding without alcoholism or portal hypertension	49
Upper GI bleeding with alcoholism or portal hypertension	12
Stools positive for occult blood	288
Hematochezia	152
Peptic symptoms	120
Upper GI obstruction	44
Dysphagia/odynophagia in a normal host	18
Dysphagia/odynophagia in an immunocompromised host	5
Chest pains unexplained by cardiac pathology	51
Therapeutic	9
Miscellaneous (including weight loss, anorexia, early satiety)	18
Total	1069

split if there was a clinical reason for separating them (e.g. upper GI series shows esophageal ulcer vs gastric ulcer).

In the second stage, the panelists met for 2½ days in Santa Monica to discuss, further revise, and rerate the scenarios. Figure 1 illustrates the format used to present the scenarios for re-rating; this example shows 24 of 120 scenarios for performing UGI endoscopy in patients with peptic symptoms and a past history of peptic disease. After rating the scenarios for patients with no comorbidity, the panelists rated them again for patients with medium and high comorbidity.

Comorbidity index

Comorbidity levels were defined using a 10-point comorbidity index made up of three components: (1) patient risk factors that could lead to complications from the procedure, (2) general limitations in health, and (3) age. Comorbidity levels were defined as follows: 2.0 or fewer points, no comorbidity; 2.1–4.9, medium comorbidity; 5 or more points, high comorbidity. Risk factors are broadly consistent with Goldman's index [15,16], Drupp's Classification system [17], and also included procedure-specific risk factors for UGI endoscopy (e.g. severe kyphoscoliosis) [18]. Risk factors could contribute as many as 5 points to the index. General limitations in health could contribute up to 3 points according to the presence of conditions such as dementia (severe = 3 points, moderate = 2 points), incon-

Endoscopy scenarios for patients with peptic symptoms with past history of peptic disease

History peptic disease	Symptoms persist or worsen despite adequate therapy*			Symptoms persist or worsen after inadequate therapy			Symptoms resolve											
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
Prior UGI shows:																		
(a) Malignant appearing lesion	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
(b) Erosion, gastritis, duodenitis	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
(c) Duodenal ulcer	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
(d) Gastric ulcer, benign appearing	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
(e) Esophageal stricture, scar or ulcer	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
(f) Esophagitis	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
(g) Within normal limits	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
(h) Not done	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9

*Definitions of "adequate therapy":

For (a) Malignant appearing lesion, adequate therapy is H2 Blocker or antacid >2 weeks; For (b) Erosion, gastritis, duodenitis, adequate therapy is H2 Blocker or antacid >2 weeks; For (c) Duodenal ulcer, adequate therapy is H2 Blocker or antacid ≥6-8 weeks; For (d) Gastric ulcer, benign appearing, adequate therapy is H2 Blocker or antacid ≥6 weeks; For (e) Esophageal stricture, adequate therapy is H2 Blocker or antacid >2 weeks; For (f) Esophagitis, adequate therapy is H2 Blocker or antacid >2 weeks; For (g) Within normal limits, adequate therapy is H2 Blocker or antacid >2 weeks; For (h) Not done, adequate therapy is H2 Blocker or antacid >2 weeks.

Circled numbers indicate how one panelist rated each listed scenario when considering patients with low comorbidity.

Fig. 1. Worksheet for assigning ratings to scenarios for patients with low comorbidity.

Table 2. Ten-point comorbidity index

Factors defining comorbidity	Number of points
Risk factors (maximum number of points = 5)	
Mild systemic disease, e.g. hypertension or weight 30% > ideal	1
Severe but not incapacitating systemic disease, e.g. insulin dependent diabetes mellitus	2
Incapacitating systemic disease that is a constant threat to life; e.g. oat cell lung cancer	4
Moribund, expected not to survive for 24 hr	5
Functional limitation (maximum number of points = 3)	
Unable to walk, e.g. because of arthritis	1
Mild to moderate dementia	2
Severe dementia or permanent nursing home residence	3
Advanced age (maximum number of points = 2)	
90 + year old female	2
85 + year old male	2

(0.0-2.5 = no comorbidity).
 (2.5-4.9 = medium comorbidity).
 (5.0-10 = high comorbidity).

tinence, or permanent nursing home residence. Advanced age was defined as 90 or over for women and 85 or over for men. It could contribute up to 2 points, so a person could not be assigned to even the medium comorbidity category based on age alone. (See Table 2.)

For example, an 86 year old severely demented man with moderate emphysema without carbon dioxide retention would be assigned high comorbidity based upon a score of 7: age, 2 points; severe systemic disease that is not incapacitating, 2 points; and health limitations (severe dementia), 3 points. A woman aged 92 who was in good health and living with her family would have a score of 2 points (assigned for age).

Rating the appropriateness of specific scenarios for different comorbidity levels

The panelists rated each of the 49 scenarios for cholecystectomy for patients with no comorbidity, and then rated all 49 scenarios again for patients with medium and high comorbidity. Because there were so many scenarios for endoscopy, the scenarios for this procedure were rated individually only for patients with no co-

morbidity. The panelists assigned comorbidity scores for each of the 14 endoscopy chapters. The comorbidity scores were used to adjust all of the scenarios in that chapter for medium and high comorbidity. We used the scores that they assigned to calculate each panelist's rating of each clinical scenario under medium or high comorbidity.

For each chapter, each panelist was asked to assign four comorbidity scores on a worksheet similar to that shown in Fig. 2. Two comorbidity scores were assigned to adjust for the presence of medium comorbidity and two to adjust for high comorbidity. For medium comorbidity, one score was assigned for scenarios originally judged by the panelist to be equivocal (4-6), and another was assigned for scenarios originally judged to be appropriate (7-9). Similarly, for high comorbidity, one score was assigned for equivocal scenarios and one for appropriate scenarios.

We used the comorbidity scores to calculate each panelist's rating for each scenario under medium and high comorbidity as follows. Take as an example the rating of the first scenario shown in Fig. 1; the panelist assigned a rating

Chapter 8: Endoscopy is indicated in patients with peptic symptoms																		
Rating with no comorbidity		Medium comorbidity								High comorbidity								
4-6	1	2	3	4	⑤	6	7	8	9	1	2	③	4	5	6	7	8	9
7-9	1	2	3	4	5	6	7	⑧	9	1	2	3	4	⑤	6	7	8	9

Circled numbers indicate how one panelist indicated adjustments for medium and high comorbidity.

Fig. 2. Work sheet for assigning comorbidity adjustments.

of 9 (extremely appropriate) for endoscopy performed in a patient without comorbidity who complained of persistent peptic symptoms despite an adequate trial of medication if a previous UGI series showed malignancy. Figure 2 shows the panelist's comorbidity scores for the chapter in which this scenario falls. The medium comorbidity score for scenarios with no-comorbidity ratings of 7-9 is shown as 7, 1 point below the midpoint of the 7-9 range (see the lower left corner of Fig. 2). Consequently, we calculated this panelist's rating for this scenario in the presence of medium comorbidity as 8 (9, the no-comorbidity rating, minus 1, the adjustment for medium comorbidity). This panelist's high comorbidity score for scenarios with no-comorbidity ratings of 7-9 was 5 (lower right corner of Fig. 2). For high comorbidity, we used an adjustment of 3 (8, the midpoint of the 7-9 range, minus 5, the high comorbidity score) to calculate this panelist's high comorbidity rating for this scenario as 6 (9, the no-comorbidity rating, minus 3, the adjustment for high comorbidity). We calculated the adjustment for scenarios previously rated 4-6 for patients with no comorbidity in a similar manner, and applied that adjustment to all no-comorbidity ratings of 6 or less. If the adjustment resulted in a rating of less than 1, we used 1; if greater than 9, we used 9.

In this paper, we analyze the effect of comorbidity on the median ratings for each scenario. We calculated the no comorbidity medians directly from the individual panelists' ratings for no comorbidity. We calculated the medium and high comorbidity medians using the individual panelists' ratings adjusted for comorbidity as described in the preceding paragraph.

RESULTS

Inter-panelist reliability, as measured by the intra-scenario correlation of the individual panelists' ratings [19], is shown in Table 3. The

Table 3. Correlations among the individual panelist's ratings

Procedure	Comorbidity		
	None	Medium	High
Endoscopy	0.55	0.57	0.41
Cholecystectomy	0.70	0.60	0.47

Note: this is the intraclass correlation coefficient calculated from a one-way analysis of variance; see Ref. [19].

Table 4. The distribution of appropriateness ratings of scenarios for two gastrointestinal procedures as a function of the patient's comorbidity status

Comorbidity category	All scenarios				Scenarios rated appropriate for patients with no comorbidity			
	Inappropriate (1-3) (%)	Equivocal (4-6) (%)	Appropriate (7-9) (%)	Total (%)	Inappropriate (1-3) (%)	Equivocal (4-6) (%)	Appropriate (7-9) (%)	Total (%)
	(n = 1069)	(n = 49)	(n = 187)	(n = 287)	(n = 287)	(n = 18)	(n = 287)	(n = 287)
Endoscopy	59	14	27	100	—	—	100	100
No comorbidity	63	20	17	100	5	32	62	100
Medium comorbidity	76	20	4	100	28	60	13	100
High comorbidity	(n = 49)	(n = 49)	(n = 18)	(n = 18)	(n = 18)	(n = 18)	(n = 18)	(n = 18)
Cholecystectomy	45	18	37	100	—	—	100	100
No comorbidity	63	14	23	100	6	33	61	100
Medium comorbidity	72	16	12	100	28	39	33	100
High comorbidity								

Note: figures may not total to 100% due to rounding.

values for endoscopy and cholecystectomy are highly significant ($p < 0.0001$, F test).

In the absence of comorbidity, 59% of the 1069 scenarios for endoscopy were rated between 1 and 3 (inappropriate), 14% rated 4-6 (equivocal), and 27% were rated 7-9 (appropriate). For patients with medium comorbidity, 17% of the scenarios remained appropriate, and for patients with high comorbidity, only 4% of the scenarios were still appropriate (Table 4). For cholecystectomy, 37% of 49 scenarios were considered appropriate for patients with no comorbidity; 12% for patients with high comorbidity.

For both procedures, the percent of scenarios rated as appropriate for patients with no comorbidity fell dramatically as comorbidity increased. As comorbidity changed from none to medium, approximately 60% of scenarios that were originally rated as appropriate for endoscopy and cholecystectomy remained appropriate. As comorbidity became high, less than one-third of the scenarios that had been appropriate without comorbidity remained appropriate: 13% for endoscopy, and 33% for cholecystectomy.

To examine the validity of the comorbidity rating process, we ranked clinical chapters of scenarios according to the severity of the clinical presentation and calculated the percent of scenarios remaining appropriate when high comorbidity was introduced within each chapter. Use of endoscopy in more than 90% of scenarios describing such urgent symptoms as upper gastrointestinal bleeding and symptoms of obstruction remained appropriate despite high comorbidity. In contrast, only 49% of previously appropriate scenarios to follow up a prior abnormal endoscopic finding remained appropriate in patients with high comorbidity. None of the appropriate scenarios for performing endoscopy in asymptomatic patients who had no comorbidity remained appropriate if high comorbidity was present (Table 5).

We used linear regression to describe the relationship between appropriateness ratings and the patient's history, UGI results, persistence of symptoms, and comorbidity (as described in the brief clinical scenarios). Regression results for patients with peptic symptoms who in the absence of comorbidity had appropriate or equivocal reasons for having endoscopy are presented in Table 6. As shown in the table, a patient could have one of five prior histories of upper gastrointestinal path-

Table 5. Change in appropriateness of performing endoscopy in patients with high comorbidity, by symptom severity

Symptom category	Appropriate scenarios remaining appropriate in patients with high comorbidity (%)
Upper gastrointestinal bleeding ($n = 61$)*	100
Obstruction ($n = 44$)	97
Follow-up to a prior upper gastrointestinal series or endoscopy ($n = 249$)	49
Stool positive for occult blood ($n = 440$)	0
Asymptomatic patient at risk for cancer ($n = 54$)	0

* n represents total number of appropriate scenarios for this symptom category (i.e. those rated 7-9 on a scale of 1-9, see text).

ology (e.g. no prior history of peptic disease); one of seven results of a prior upper gastrointestinal series (e.g. the presence of a gastric ulcer); one of three categories of symptoms in

Table 6. Ordinary least squares regression of the panel's median appropriateness rating for patients with peptic symptoms

Variables	Regression coefficient estimates
Intercept	5.6
Prior history of:	
Peptic disease	—
Esophagitis	-0.3*
Gastric bypass surgery	-0.8*
No peptic disease	-0.2
Gastrectomy	-0.1
Upper gastrointestinal series result:	
Duodenal ulcer	—
Non ulcer peptic disease	0.3
Normal	1.0*
Not done	0.9*
Esophagitis	0.5
Gastric ulcer	2.3*
Esophageal stricture	2.7*
Upper gastrointestinal cancer	3.6*
Symptoms:	
Resolve	—
Persist after inadequate or no therapy	-0.3*
Persist despite adequate therapy	1.2*
Comorbidity:	
None	—
Medium	-0.5*
High	-2.9*
$R^2 = 0.86$	
$n = 231$	

* $p < 0.05$.

(—) This variable was omitted. All other variables are dummy (0,1) variables with 1 indicating that the condition is present. This table includes only those indications that, in the absence of comorbidity, had equivocal or appropriate ratings. [See text for two examples.]

relation to the use of therapy (e.g. symptoms persistent despite adequate therapy); and one of three categories of comorbidity (none, medium, and high). Each category was represented by a dummy variable equal to 1 if the patient was in that category and 0 otherwise.

Based on the regression, examples of predicted appropriateness ratings for two specific patients are presented below. A patient with a prior history of esophagitis, whose upper gastrointestinal series shows esophagitis, and whose peptic symptoms persist despite an adequate course of medical therapy would have, in the absence of comorbidity, a rating of 7.0; performing an endoscopy would be considered appropriate ($5.6 - 0.3 + 0.5 + 1.2 + 0 = 7$). When high comorbidity is introduced, the predicted rating of appropriateness would drop to 4.1 points, an equivocal rating ($5.6 - 0.3 + 0.5 + 1.2 - 2.9 = 4.1$). A patient with no prior history of peptic disease, whose upper gastrointestinal series shows a gastric ulcer, whose symptoms persist despite adequate therapy and who has no comorbidity, would have an appropriateness rating for performing an endoscopy of 8.9 which would drop to 6.0 points as high comorbidity is introduced.

We also ran three separate regressions to determine the relative importance of UGI results, comorbidity, history, and persistence of symptoms in determining appropriateness ratings. Forty-five percent of the variance for the subset of appropriate and equivocal scenarios is explained when the comorbidity variables are entered into the model; 27% of the variance is explained when only the results of the upper gastrointestinal series are entered; and 4% of the variance is explained when only symptoms and historical findings are entered.

DISCUSSION

Comorbid conditions have a marked effect on physician ratings of the appropriateness of performing two gastrointestinal procedures. As comorbidity changes from none to high, only a fraction of previously appropriate scenarios remain appropriate: 13% for endoscopy, and 33% for cholecystectomy. These findings are consistent with competent clinical practice. The decision to perform any procedure requires a weighing of risk and benefit. Comorbid conditions can both increase the risk and decrease the benefit, making it less appropriate to do the procedure.

These results have important implications for understanding disagreements among physicians about when to use a procedure and for evaluating the appropriateness of using medical procedures. One reason physicians may disagree about the value of a diagnostic or therapeutic intervention in a particular patient may actually stem from a differential appreciation of the importance of comorbid conditions. It is also possible that physicians differ in their recognition of the existence of comorbid conditions. Further research will be needed to better understand the effect of comorbidity on physician decision-making about the use of specific procedures. Refining the qualitative and quantitative measures of comorbidity is also a ripe area for future study.

In the meantime, attempts to determine appropriateness of using medical and surgical procedures must consider patient comorbidity and measure its presence or absence. This is especially important when appropriateness is being measured in the elderly, in whom comorbid factors are most likely to be present.

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