

A RAND NOTE

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and Bypass Surgery**

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CLINICAL PRACTICE

Audit of coronary angiography and bypass surgery

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The appropriateness of coronary angiography and coronary artery bypass surgery in the Trent regional health authority was assessed by comparison with predetermined consensus criteria. 49% of coronary angiographies were considered to be entirely appropriate in relation to the patient's clinical condition, but 21% were deemed inappropriate. Coronary artery bypass surgery was considered appropriate in 55% of patients, but inappropriate in 16%. Audit by "appropriateness" scores may help to determine which patients should first be investigated and treated when resources are limited and waiting lists are long.

Lancet 1990; 335: 1317-20.

Introduction

Medical practice and medical audit should ideally be based whenever possible on the results of large randomised clinical trials, but where no such data exist other techniques may have to serve. One method is to obtain a consensus opinion as to appropriateness of treatment in relation to given symptoms, signs, and investigation results¹—but, although guidelines established by expert panels may influence medical practice, they depend on the panel members and sometimes on the skilful advocacy of one person. The consensus view of one panel may not reflect the views of other equally experienced doctors elsewhere, so in the absence of clinical trial results the most appropriate management for a patient may be unclear, and audit of medical care becomes extremely difficult. Before an audit of coronary angiography and coronary artery bypass graft surgery in the Trent regional health authority, a panel of local physicians and cardiothoracic surgeons assessed a series of hypothetical cases to obtain an "appropriateness" score for either procedure—as used to compare the attitudes of British and American cardiologists.² These ratings were then applied to patients who had recently undergone coronary angiography and coronary artery bypass graft operations to audit use of these procedures in the region.

Methods

Appropriateness of treatment was determined by a modified Delphi technique.^{3,4} Briefly, after review of published data and discussion between clinicians, a set of 490 hypothetical clinical indications for coronary angiography and 483 for coronary artery bypass graft operations were derived; both lists were mutually exclusive and comprehensive, and included all conceivable circumstances in which coronary angiography or coronary artery bypass surgery might be contemplated. Clinicians were asked on two separate occasions to rate these hypothetical indications on a scale of 1 to 9 in accordance with the perceived degree of appropriateness for

coronary angiography or coronary artery bypass surgery. An extremely appropriate indication was rated as 9, and proportionately less appropriate indications allocated a progressively lower rating down to 1 (extremely inappropriate). When the expected benefit to health in terms of increased life expectancy, symptom relief, or improved function exceeded the potential mortality or morbidity of the procedure it was considered "appropriate"; when potential benefit was thought to equal potential harm the procedure was "equivocal"; or deemed to be "inappropriate" when potential harm exceeded likely benefit. The highest and lowest ratings were discarded and the median of the 7 remaining ratings was calculated. If the median rating was 1-3 the procedure was considered inappropriate; 4-6 equivocal; and 7-9 thought appropriate.

On the first occasion, ratings were made individually; on the second, they were obtained some time later after a panel discussion—but all ratings were confidential. The panel comprised two consultant cardiothoracic surgeons, a consultant cardiologist, two consultant physicians, a consultant radiologist, two researchers with a clinical interest in cardiology, and a general practitioner. Two medically qualified researchers collected detailed information from the regional centres and referring hospitals on a random sample of patients from the Trent region who had undergone coronary angiography or coronary artery bypass surgery. In the Trent regional health authority coronary angiography is done in 3 referral centres and coronary artery bypass surgery in 2. A systematic random sample of angiography and bypass graft cases was taken from cardiac catheter and operating theatre logbooks. Overall, 3382 patients underwent coronary angiography between Feb 1, 1987, and May 30, 1988, 2960 (88%) of whom were treated by physicians who took part in the study. 741 patients were selected at random from the 2960 logbooks: 87% of all medical records were located and reviewed; data was incomplete for 2 patients, who were excluded. 339 patients were evaluated because of congenital heart disease or primary valve disease, or for possible heart transplant, and were also excluded from the study. Thus records of 320 patients who underwent coronary angiography were reviewed.

Between July 1, 1987, and June 30, 1988, 707 patients underwent coronary artery bypass surgery for coronary artery disease (patients with primary valvular disease were excluded). All cardiac surgeons participated in the study. 376 records were reviewed, and 87% of notes were located; records were incomplete or missing for 7 patients, who were excluded from the study. Thus casenotes of 319 patients who had had bypass surgery were reviewed.

After data collection it was possible to allocate every patient to one of the predetermined clinical indications: by comparison to the earlier panel decision for each hypothetical case, the appropriateness of the management of the patients was determined.

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Results

The panel rated 88 (18%) of 490 hypothetical sets of data to be appropriate indications for investigation by coronary angiography, 147 (30%) to be equivocal, and 255 (52%) to be inappropriate. The most common hypothetical clinical indications and panel ratings, and the numbers of patients who, on review, met those categories were:

<i>Hypothetical sets of data</i>	<i>No on review</i>
Appropriate	
<i>Chronic stable angina, class III/IV</i>	19
Very positive exercise test	
No exercise scintigraphy	
Maximum medical therapy	
<i>Unstable angina within 3 mo of onset</i>	15
Under age 65	
Angina recurs, class III/IV	
Maximum medical therapy	
<i>Chronic stable angina, class III/IV</i>	13
Positive exercise test	
No exercise scintigraphy	
Maximum medical therapy	
<i>Chronic stable angina, class III/IV</i>	12
Very positive exercise test	
No exercise scintigraphy	
Submaximum medical therapy	
Equivocal	
<i>Chronic stable angina, class III/IV</i>	24
No exercise test	
No exercise scintigraphy	
Maximum medical therapy	
<i>Chronic stable angina, class I/III</i>	12
No exercise test	
No exercise scintigraphy	
Ejection fraction unknown	
Maximum medical therapy	
<i>Unexplained cardiomegaly/heart failure</i>	7
<i>Myocardial infarction in previous 6 mo</i>	6
Q wave infarct without heart failure	
Postinfarction angina, class I/II	
Submaximum medical therapy	
Inappropriate	
<i>Chest pain of unknown origin</i>	13
Over age 50 yr	
No exercise test	
No exercise scintigraphy	
<i>Chronic stable angina, class I/III</i>	11
Under age 65 yr	
Positive exercise test	
No exercise scintigraphy	
Ejection fraction unknown	
Submaximum medical therapy	
<i>Chronic stable angina, class III/IV</i>	9
No exercise test	
No exercise scintigraphy	
Submaximum medical therapy	
<i>Chronic stable angina, class I/III</i>	6
Under age 65 yr	
No exercise test	
No exercise scintigraphy	
Ejection fraction unknown	
Submaximum medical therapy	

The panel rated 304 (63%) of 483 hypothetical clinical indications to be appropriate for surgery, 121 (25%) to be equivocal, and 58 (12%) to be inappropriate. The most common hypothetical indications and panel ratings, and the numbers of patients who, on review, met those criteria were:

<i>Hypothetical sets of data</i>	<i>No on review</i>
Appropriate	
<i>Chronic stable angina, class III/IV</i>	41
3-vessel disease	
Ejection fraction > 20%	
Maximum medical therapy	

Appropriate (continued)	
<i>Chronic stable angina, class III/IV</i>	25
2-vessel disease including LAD	
No/indeterminate/negative or positive exercise test	
Ejection fraction > 20%	
Maximum medical therapy	
<i>Chronic stable angina</i>	21
Left main-stem disease	
Ejection fraction > 20%	
<i>Chronic stable angina, class I/III</i>	11
3-vessel disease	
Ejection fraction > 50%	
Maximum medical therapy	
<i>Chronic stable angina, class I/III</i>	15
3-vessel disease	
Ejection fraction 20-49%	
Maximum medical therapy	
Equivocal	
<i>Chronic stable angina, class I/III</i>	13
3-vessel disease	
Ejection fraction 20-49%	
Submaximum medical therapy	
<i>Chronic stable angina, class I/III</i>	13
2-vessel disease including LAD	
Ejection fraction > 20%	
Maximum medical therapy	
Inappropriate	
<i>Chronic stable angina, class I/III</i>	11
2-vessel disease including LAD	
Ejection fraction > 20%	
Submaximum medical therapy	
<i>Chronic stable angina, class I/III</i>	8
Single vessel not involving proximal LAD	
Not a candidate for angioplasty	
Submaximum medical therapy	
<i>Unstable angina</i>	7
Non-emergency procedure	
Angina responds to medical therapy	
2-vessel disease not involving LAD	
Not a candidate for angioplasty	
Ejection fraction > 20%	

(LAD = left anterior descending coronary artery).

Table I shows the demographic and clinical characteristics of all patients who underwent coronary angiography or coronary artery bypass surgery. Of the 320 who were investigated by coronary angiography, most were men with moderate or severe chronic stable angina and 58% had had a myocardial infarction. In the year before catheterisation 51% had undergone an exercise stress test, most of which had been positive; few had had an echocardiogram and only 2% had undergone exercise scintigraphy. Two-thirds had had angina for one year or more before angiography; over half were found to have significant left main-stem disease or multivessel disease that involved the left anterior descending branch.

Of 490 hypothetical indications for coronary angiography, 73 were represented in the sample of patients—14 of which described half the sample. When the panel ratings were applied to the patients, 49% were considered appropriate for coronary angiography, 30% were equivocal, and 21% were inappropriately investigated, for whom further review of the records failed to reveal any significant errors in data collection or analysis which might have altered the category of angina to which the patient had been allocated. Of the cases considered by the panel to be inappropriate for coronary angiography, 18% had no significant disease or no disease at all, 44% continued on medical treatment, and 38% had coronary artery bypass surgery. One or more members of the panel had been

TABLE I—DEMOGRAPHIC AND CLINICAL CHARACTERISTICS OF PATIENTS

	Angiography (n = 320) %	CABG (n = 319) %		Angiography (n = 320) %	CABG (n = 319) %
<i>Age (yr)</i>			<i>Chronic pulmonary disease</i>	7	8
25-44	11	11	<i>Congestive cardiac failure</i>	14	17
45-54	30	31	<i>Duration of treatment</i>		
55-64	40	41	1-3 mo	7	3
≥65	19	17	4-6 mo	14	6
<i>Severity of angina</i>			7-11 mo	13	14
Class III-IV	60	60	≥1 yr	65	75
Class I-II	28	37	<i>Maximum tolerated medical treatment</i>	47	60
None: no data	12	3	<i>Anti-anginal drug treatment</i>		
<i>Men</i>			1 agent	27	20
<i>Previous MI</i>	58	63	2 agents	27	31
<i>Previous CABG</i>	6	4	3 agents	26	37
<i>Echocardiogram</i>	16	14	4 agents	8	5
<i>Exercise scintigraphy</i>	2	2	<i>Drugs intolerance</i>		
<i>Exercise stress test</i>			β-blocker	12	9
Positive	51	40	Nitrates	5	5
Negative	42	38	Calcium antagonist	6	6
Indeterminate	7	1	<i>Angiography results</i>		
<i>Hypertension</i>	33	28	Left main-stem disease	11	15
<i>Diabetes mellitus</i>	3	4	3-vessel disease	34	46
<i>FH coronary artery disease</i>	15	15	2-vessel (incl LAD)	15	23
<i>Cigarettes > 10 daily</i>	10	5	2-vessel (excl LAD)	5	4

CABG = coronary artery bypass graft; MI = myocardial infarction; FH = family history; LAD = left anterior descending coronary artery.

involved in the care of over half the patients whose investigations had been considered inappropriate; these results were not uniform in the three regional centres (table II).

Of 319 patients who underwent coronary artery bypass surgery, most were men with moderately severe chronic stable angina; 63% had had a myocardial infarction, 40% had had an exercise stress test in the previous year, few had had an echocardiogram, and only 2% had undergone exercise scintigraphy. Over 80% had significant left main-stem disease or multivessel disease that involved the left anterior descending branch. When the panel ratings were applied to the patients, 58% were considered appropriate for surgery, 26% equivocal, and 16% were inappropriate. In those thought to have been inappropriately treated, 94% had mild to moderate angina (class I or II), and the other 6% had class III angina but were not on maximum medical treatment; 79% had a negative or indeterminate exercise stress test and 17% had had no exercise test at all; 86% had had angina for less than 6 months; and 29% had been admitted to hospital because of unstable angina. These results were similar in both cardiothoracic surgery centres.

Discussion

The concept of clinical audit is based on a comparison of actual practice with that of an established ideal. But what is ideal treatment? Clinical practice should be based on the results of randomised clinical trials, but in ischaemic heart disease—and, indeed, many other illnesses—trial data are inadequate to determine the best way to treat every clinical

problem. Supporters of clinical judgment as the final arbiter of correct patient management still exist,⁵ but is one clinician's opinion adequate? Until sufficient trial data are available, one way to establish such norms is to codify clinical opinion. However, there are several ways in which this might be done.

The method we used to obtain ratings of appropriateness is unlike a consensus development panel,¹ in that it is not essential to achieve complete agreement: for many hypothetical clinical problems all clinicians can rapidly agree on optimum management, but for others there will be considerable disagreement. To insist on the need for a full consensus would mean that clinical management was based on the lowest common denominator to which no panellist could take exception, but which is therefore unlikely to be of much clinical use. Different panels may come to different conclusions of what is appropriate treatment, but experience in the US indicates that agreement between panels is surprisingly good (Chassin MR: personal communication).

We felt that ratings of appropriateness established by local clinicians who were actively involved in patient care were the most suitable means to audit investigation and management of patients in separate hospitals from the same health region. Before the study, we had assumed that investigation and treatment would mostly be found to have been entirely appropriate, at least by the standards set by our own clinicians. The Trent regional health authority is poorly funded, even by comparison to other UK health regions, and we had assumed that habitual rationing of our limited resources would restrict access to investigation and treatment, so that patients would only receive sophisticated and expensive management if they obviously stood to gain from it. However, when the panel's hypothetical ratings were applied to a random selection of patients, we were surprised to find that the management was considered inappropriate in 21% who underwent coronary angiography and 16% who had coronary artery bypass surgery. The reasons for such inappropriate action were not always obvious on review of patient records. In some cases,

TABLE II—APPROPRIATENESS RATINGS OF CORONARY ANGIOGRAPHY BY CENTRE

Centre	Appropriate	Equivocal	Inappropriate
1	50 (37)	48 (36)	37 (27)
2	62 (46)	35 (26)	38 (28)
3	85 (63)	37 (27)	14 (10)

Values shown as numbers of patients (% at that centre).

investigation probably resulted from frustration on the part of the clinician at the lack of a certain diagnosis, or a desire to come to a diagnosis "once and for all". In a few cases the clinical records were inadequate, but in most patients who underwent inappropriate angiography or bypass grafting, review of the case notes showed that the procedure was indeed "inappropriate" by the standards set by the panel. However, two factors should also be considered. First, it is probably inevitable that discussions will make the panel more conservative than some of its individual members, whose actions in individual patients might be more aggressive than they would be prepared to admit. Second, investigation or treatment considered inappropriate by standards laid down by a panel does not necessarily mean that the clinician who managed the patient was wrong. 30% of the patients in whom coronary angiography was considered "inappropriate" were found to need coronary artery bypass surgery. But when resources are limited, waiting lists are long, and choices have to be made about whom to investigate and treat, ratings of appropriateness seem to be a reasonable way to establish guidelines. A similar proportion of patients was investigated inappropriately in two centres, while in the third fewer procedures were inappropriate by the panel's standards. We cannot be sure that the patients from the third centre received a better (or worse) standard of care but would argue that, in the third centre, resources were used more effectively.

Audit by ratings of appropriateness is obviously less satisfactory than audit related to clinical trial results, but is preferable to an audit in which the only arbiter of correct management is the clinical judgment of an individual. The technique we describe could readily be applied to other illnesses.

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