THE BURST ABDOMEN

BY

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The purpose of this paper is to review the cases of burst abdomen which occurred in the United Oxford Hospitals in the 12 years 1949-60. The main objects of the investigation were to determine the truth of the commonly held belief (Aird, 1957) that men burst their wounds more frequently than women, and to find out, by comparison with a control group of patients whose wounds remained intact, how many of the factors often incriminated (such as suture material) are important. There has hitherto been only one series (Colp, 1934) in which there was any attempt to show the difference in frequency of bursting between men and women, and in no paper has there been a comparison with a control group.

Materials and Methods

The cases were selected from the hospital operations index of "secondary sutures" (Code No. 010-73, Standard Nomenclature of Diseases and Operations of the American Medical Association, 1952). All the patients who were returned to theatre for secondary suture of their abdominal wounds were considered, and a "burst abdomen" was taken to have occurred when all the layers down to the peritoneum had parted, although the peritoneum itself was sometimes intact. Of the cases reviewed, 120 fitted this definition.

Since patients who undergo multiple procedures during a single operation are recorded more than once in the hospital operations index, the number of operative procedures is greater than the number of patients involved. Therefore in order to estimate the number of patients the total number of abdominal operative procedures (excluding herniorrhaphies) was counted and multiplied by a reduction factor; this factor was calculated by drawing large samples of patients from the operations index and estimating the average number of procedures per patient. The estimated total number of patients is thus liable to error, but it is fairly certain (95% probability) that the true value is within 4% of 30,610, and that the separate totals for men and women are within 8% of 13,650 and 16,960 respectively. The same samples were used to estimate the number of abdominal operations performed in each month, and also the age and sex distribution of the patients involved. These totals have been used as denominators in Fig. 1 and Tables I and II.

Since the frequency of bursting in men and women of various age-groups can be calculated by these methods reasonably precisely it seemed that a control group matched for age and sex would give most information about other factors. A control group was selected by finding the position in the theatre record book of each patient who subsequently suffered from a burst abdomen, and by taking the next patient of the same sex and in the same five-year group to have an abdominal operation (again excluding herniorrhaphies) as the control. The two groups of patients will be referred to as the "burst" and the "control" groups.

Results

Effect of Age and Sex.—The frequencies of bursting in men and women of different ages are shown in Fig. 1. There were 120 burst abdomens in 30,610 operations, an

overall frequency of 0.39%. There were 82 men who burst after 13,650 operations (0.60%) and 38 women after 16,960 operations (0.19%). This difference of frequency between the sexes is highly significant ($P < 0.01$) even when a generous allowance is made for possible inaccuracies in the estimation of the total numbers of operations. It is evident from Fig. 1 that there is a fairly steady increase in frequency of bursting with age in both sexes, except in the very old, where the totals involved are small.

Year and Month of Operation.—The number of burst abdomens varied randomly from year to year, but not from month to month: there were 40 in the summer months of April to September inclusive (28 men, giving a frequency of 0.38%, and 12 women, 0.14%) and 80 in the winter (54 men, 0.85%, and 26 women, 0.31%).

Nature of Primary Disease and Operation.

The common diagnoses in the burst and control groups are shown in Table I. The only

striking differences between the two groups are the larger numbers of cases of appendicitis and prostatic hypertrophy among the controls; however, as is explained below, it seems very probable that this is due to the site and type of incision involved in these conditions. It was not possible

FIG. 1.—Frequency of burst abdomen by age and sex.

TABLE I.—Comparison of Common Primary Diseases in the Burst and Control Groups

	Men		Women		Total	
	Burst	Control	Burst	Control	Burst	Control
Cancer (all types) ..	30	22	10	11	40	33
Peptic ulcer ..	25	20	2	0	27	20
Gall-stones ..	5	4	3	5	8	9
Appendicitis ..	2	13	2	6	4	19
Prostatic hypertrophy ..	0	12			0	12
Fibroids of uterus ..			6	5	6	5
Remainder ..	20	11	15	11	35	22

to calculate the frequencies of bursting for individual diagnoses because the records of diagnoses and operations are not cross-indexed. The three main groups of operations after which burst abdomens occurred were those on the stomach (mainly for peptic ulcer), on the biliary tract (including simple cholecystectomies and by-pass operations), and gynaecological operations: the frequency of bursting after each of these is shown in Table II.

Effect of Sex, Age, Season, and Operation.—There appears from the above figures to be a greater risk of wound separation in old age, in men, in winter, and after operations on the stomach and biliary tract. It is difficult to apply significance tests to these figures, but that the differences are real is suggested by the observation that

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when cross-tabulations are made on the basis of these factors the differences appear in almost every subgroup: this is shown in Table III. From the table it is evident that for given age, season, and operation the frequency of bursting is higher in men than in women; for given sex, season, and operation the frequency is higher in the over-fifties; and for given age, sex, and operation the frequency is higher in the winter months except in one instance.

TABLE II.—Frequency of Burst Abdomen by Type of Operation

	Men			Women		
	Burst	Ops.	Frequency	Burst	Ops.	Frequency
Stomach ..	28	3,250	0.86%	2	890	0.22%
Biliary tract ..	11	620	1.76%	5	2,260	0.22%
Gynaecological ..				20	6,090	0.33%
Other ..	43	9,780	0.44%	11	7,710	0.14%

TABLE III.—Frequency of Burst Abdomen by Sex, Age, Season, and Type of Operation

	Men						Women					
	Under 49			Over 50			Under 49			Over 50		
	B.	Ops.	F. (%)	B.	Ops.	F. (%)	B.	Ops.	F. (%)	B.	Ops.	F. (%)
Stomach :												
Summer ..	2	1,140	0.18	9	820	1.1	0	180	0	0	320	0
Winter ..	4	710	0.51	13	570	2.3	0	180	0	2	220	0.93
Biliary :												
Summer ..	0	70	0	2	240	0.83	0	410	0	1	740	0.14
Winter ..	0	100	0	9	220	4.17	0	530	0	4	580	0.70
Gynaecological :												
Summer ..							4	2,550	0.16	2	650	0.31
Winter ..							6	2,090	0.30	8	800	1.0
Other :												
Summer ..	1	2,610	0.04	14	2,420	0.58	0	2,600	0	5	1,060	0.48
Winter ..	8	2,410	0.33	20	2,340	0.86	1	2,760	0.04	5	1,290	0.39

Mortality.—A consistently higher mortality was found in the patients who had burst than in the controls, but it was not possible to evaluate the extent to which the actual bursting of the wound contributed to death. In the group who burst, 15 (19%) of 80 patients who did not have cancer died within a month of the original operation, as did 12 (30%) out of 40 who had cancer. The overall mortality after bursting was therefore 23%. In the control group 16 (13%) died within a month of operation—8 (24%) of the 33 with cancer and 8 (9%) of the 87 with other conditions.

Day of Bursting.—The proportion of men and women who burst at various times is shown in Fig. 2. The vast majority of the burst abdomens occurred from the fifth to the twelfth day: the pattern was similar in men and women. In several cases the bursting was noted to have been associated with a sudden rise of intraperitoneal

Fig. 2.—Intervals between the operations and bursting of the abdomen.

pressure, due to a paroxysm of coughing or straining at stool, but in several others the wound gaped immediately the skin stitches were removed—in these cases presumably the deeper layers had parted much earlier. A common precursor of bursting was a serous or sero-sanguineous discharge from the wound.

Pre-operative Factors

The presence or absence of a cough was recorded on admission in 88 of the burst group and 98 of the controls: a comparison of the two groups is shown in Table IV. The presence of a cough was noted in a considerably higher proportion of the burst group, and its absence was much more common in the controls. These differences are statistically highly significant (P approximately 0.01). A cough in the post-operative period was also much more

TABLE IV.—Presence of Pre-operative Cough

	Men		Women		Total	
	Burst	Control	Burst	Control	Burst	Control
Cough ..	34	24	9	5	43	29
No cough ..	29	46	16	23	45	69
No record ..	19	12	13	10	32	22
Total ..	82	82	38	38	120	120

common in the burst group (see Table VI). It was not possible to assess the importance of smoking, because the smoking habits were recorded in only 39 of the burst group and 36 of the controls: there were no marked differences between the two groups.

A comment about the trend of the patients' weights was frequently recorded: there was a slight excess of falling weights in the burst group, but the difference was not statistically significant.

The pre-operative haemoglobin level was recorded in nearly all cases. Levels lower than 80% were present in 29 (24%) of the burst group as opposed to 17 (14%) of the control group. This difference is not quite significant at the 5% level.

There was no difference between the burst and control groups in the parity of the women, nor was there any difference in the numbers of women who were still menstruating. Of the 13 women who were pre-menopausal and whose wounds burst, nine had a total hysterectomy and bilateral salpingo-oophorectomy and one had one ovary and part of the other removed. Of the 12 women in the control group who had not reached the menopause, seven had a total hysterectomy and bilateral salpingo-oophorectomy.

The Operation

The type of incision used was recorded in nearly all cases. In the men, 70 (85%) of the burst group had upper abdominal incisions as opposed to 41 (50%) of the controls; and 76 (93%) of the burst group had vertical incisions as opposed to 56 (68%) of the controls. In the women the numbers of upper abdominal incisions were nearly equal in the two groups, but again vertical incisions were more common in the burst group: 25 (66%) as opposed to 15 (40%). No lower abdominal oblique or transverse wounds burst.

The materials used to suture the muscles and fascia are shown in Table V. Very similar numbers in the two groups were repaired with catgut and nylon, and so it seems most unlikely that the material used has any influence on the subsequent bursting of the wound. Of the seven

TABLE V.—Suture Material Used for the Muscle and Fascia

	Burst	Control
Catgut ..	47	45
Nylon ..	40	43
Silk ..	1	1
No record ..	32	31
Total ..	120	120

patients whose wounds separated in the first three days the suture material was reported to have come untied in two and to have broken in two.

Post-operative Conditions

Conditions which cause a rise in intraperitoneal pressure (cough, vomiting, distension, and ascites) were all found to be much more common in the burst group than in the controls. In the burst group 19 patients had two of these conditions and eight had three; in the control group eight had two and none had three. In 40 of the burst group and in 66 of the controls there was no record of any of these complications.

Wound inflammation, which was taken to have been present if a swab was sent for culture, was also more common in the burst group.

The various complications present are shown in Table VI. The larger number of patients in the burst group to have any of these complications is statistically highly significant (P approximately 0.001).

TABLE VI.—Numbers of Patients with Various Post-operative Complications in 120 Cases of Burst Abdomen and 120 Controls

	Burst	Control
Cough	44	15
Distension	29	10
Vomiting	25	9
Ascites	7	1
Hiccups	3	3
Wound inflammation	17	8

Heparin, which it has been suggested may prevent normal healing, was used in the post-operative period in three men who burst—one with mesenteric artery thrombosis, and two after ilio-femoral endarterectomy. It was not used in any of the control group.

Method of Repair

Since the cases of the burst abdomen were selected from the operations index which recorded their repair, this series includes only cases treated by surgery. The methods used varied: some were resutured under general and some under local anaesthesia, and some surgeons repaired the wound in layers and some with through-and-through sutures. There was only one patient who burst twice: this was a 70-year-old woman with pseudomucinous cystadenocarcinoma of the ovary with pseudomyxoma peritonei who had been treated with intraperitoneal radioactive gold.

Discussion

The frequency of burst abdomen after abdominal operations and the ensuing mortality reported in this paper are comparable with post-war series in the American literature (Tweedie and Long, 1954; del Junco and Lange, 1956) and show a considerable improvement over pre-war figures: Hartzell and Winfield (1939) reviewed 28 papers and considered that the frequency of bursting was between 1 and 2%, and the resulting mortality about 40%. It is not possible to evaluate the relative importance of changes in anaesthetics, blood transfusion, antibiotics, fluid balance, and so on which have occurred since then.

The only report of the frequency of bursting by sexes hitherto published is that of Colp (1934), who found it to be 1.12% for men and 0.75% for women. Other authors show an excess of men (Mayo and Lee, 1951; del Junco and Lange, 1956) but do not give the numbers of operations involved. This series shows that the frequency in men is three times that in women, but does not provide support

for any of the previous theories which accounted for the difference, such as the excessive consumption of alcohol and tobacco by men (Colp, 1934) or the laxity of the abdominal wall of parous women (Mayo and Lee, 1951); nor do the details of menstruation or operations involving removal of the ovaries allow the effect of female sex hormones on wound healing (Sjövall, 1953) to be invoked.

There appears to be a definite increase in frequency of bursting with age, and the small difference between the burst and control groups in numbers of patients with cancer suggests that it is age rather than cancer which is important.

Sokolov (1932) first noticed that burst abdomens were more common in the winter, but this was denied by several later authors (Joergenson and Smith, 1950; Landry *et al.*, 1950). The present series shows a very definite seasonal effect, the winter frequency being twice that of the summer.

Among pre-operative factors general physical condition has in the past been thought important (Joergenson and Smith, 1950; Wolff, 1950), but the only indications that this may be so are the slight excess of falling weights and of low haemoglobin levels in the burst group.

The importance of pre-operative cough has not previously been emphasized: it seems quite possible that the difference between the sexes can be attributed to the higher prevalence of chronic cough in men, and the difference between winter and summer may be due to the higher prevalence of coughs in winter.

There was a high frequency of bursting after operations on the stomach and biliary tract, and incisions in the upper abdomen were found to rupture more often than those in the lower abdomen: it is not possible to separate the relative importance of the organ operated upon and the site of the incision. Anatomical factors which might make vertical upper abdominal wounds more likely to burst are the transverse arrangements of the fibres of the posterior rectus sheath, the elastic fibres of the skin, and the vascular supply of the abdominal wall. Movements of the thoracic cage also affect the upper abdomen more than the lower, and here again coughing may be the most important factor.

There has been considerable argument about the importance of suture material (*Brit. med. J.*, 1961); there is no evidence that this has any effect.

Abdominal wounds rarely burst a second time (Mayo and Lee, 1951) and the only patient in this series to suffer two bursts was unique in having treatment with intraperitoneal radioactive gold. It is possible that the protection from a second burst is related to the local wound-healing mechanism which seems to operate when experimental wounds are reopened (Douglas, 1959).

Summary

A review has been made of 120 cases of burst abdomen which occurred from 1949 to 1960 in the United Oxford Hospitals. Frequency rates were computed, using samples from the operations index. The overall frequency of bursting was 0.39 per 100 operations; for men it was 0.65% and for women 0.19%.

The risk of bursting increased sharply with age in both sexes. A striking seasonal effect was shown, the risk in winter being twice that in the summer. There was a high frequency of bursting after operations on the stomach and biliary tract.

The cases were also compared with a control group matched for age and sex in respect of other variables. The presence of a cough, both before and after the operation,

appears to be a highly important factor, as do other post-operative causes of increased intra-abdominal pressure such as vomiting, distension, and ascites. Incisions in the upper abdomen, and vertical incisions, carry a high risk of bursting.

There is no evidence that the type of suture material used is of any importance.

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CLINICAL COMPARISON OF BARBITURATES AS HYPNOTICS

BY

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The classification of barbiturates by the duration of their action into long, intermediate, short, and ultra-short was based on the results of animal experiments by Fitch and Tatum (1932). They gave 60% of the minimum lethal dose of each barbiturate to rabbits and rats, and noted the time taken for the animals to wake. Over 40 animals were used to test each barbiturate, and the drugs were administered orally and intraperitoneally. A wide range of hypnotic action was noted. Nevertheless, Bleckwenn as early as 1930, using medical patients, reported little difference between intermediate- and short-acting groups.

It is widely accepted that phenobarbitone has less hypnotic action and is more likely to produce a hangover than intermediate and short-acting barbiturates. This is stated in several standard works (Wilson and Schild, 1959; Alstead, 1960; *British National Formulary*, 1960). Lasagna (1956), however, using medical patients, showed in a well-controlled trial that phenobarbitone in doses of 100 mg. could hardly be distinguished from quinalbarbitone or pentobarbitone in the same dose in respect of either sedation or hangover. Wayne (1960) has drawn attention to this and similar studies which have thrown doubt on the clinical relevance of the pharmacological classification of the barbiturate series into short-, intermediate-, and long-acting members and has suggested that the position should be reviewed. This problem has therefore been investigated using the relatively simple technique of sequential analysis.

Method

The trial has been conducted in general medical wards. A study was made of 173 patients—91 men and 82 women. Only those patients who had previously benefited from a hypnotic were included and no patient aged over 70 was used. Other sedatives were withheld. Six successive clinical trials were carried out using the same method. The drugs to be compared were dispensed as identical white tablets in containers marked A and B; their content was known only to the pharmacist. On the first night a number of patients would receive tablet A and the remainder tablet B. On the second night this was reversed. The order of giving tablets A and B was decided by random selection as described in a previous trial (Parsons and Thomson, 1961). In the morning after the second hypnotic each

patient was asked two questions. "On which of the last two nights did you have the better sleep?" and, "Have you had any hangover or drowsiness on waking after either of these drugs?" An identical form of question was used in every case.

The results were examined by the now familiar method of sequential analysis described by Bross (1952), and further explained by Armitage (1960). Only a preference between A and B is plotted as X; if the patient states there is "no difference" between treatments no entry is made on the chart. These trials have been so designed that a preference for A is charted vertically and for B is charted horizontally. When the X path crosses the upper border of the boxed area, tablet A is superior, and if it crosses the lower border then tablet B is superior. If the plotted results cross the boundary in the V shape between the boxed areas, this denotes no important difference between treatments. The clinical trial to compare A and B ends when the X path crosses any boundary of the boxed area.

Results

The results for trials 1-3 are shown in the figures and for trials 4-6 are reported only in the text. For convenience the contents of tablets A and B have been entered on the figures. The first trial (Fig. 1) showed that quinalbarbitone 100 mg. was superior to an inert tablet consisting of lactose and starch. To reach this conclusion nine patients were studied, of whom eight stated a preference and one could detect no difference. Two patients complained of hangover with quinalbarbitone. The second trial (Fig. 2) demonstrated no important difference between 100 mg. of quinalbarbitone and 100 mg. of phenobarbitone. In order to complete this study 47 patients were used, of whom 34 gave a preference and 13 no difference results. Five patients complained of hangover—two with quinalbarbitone and three with phenobarbitone—and one patient was restless after phenobarbitone. Fig. 3 shows the comparison of 100 mg. of butobarbitone and 100 mg. of quinalbarbitone carried out in the third trial. It shows no important difference after a total of 27 patients had been studied, five giving no difference results. Three patients complained of hangover with quinalbarbitone, none with butobarbitone.

The fourth trial showed 200 mg. of quinalbarbitone to have superior hypnotic effect when compared with 200 mg. of phenobarbitone. This conclusion was reached after 46

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