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# OPERABILITY IN THE YOUNG AND AGED*

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SURGEONS RECOGNIZE that under most circumstances, operations on elderly patients are more hazardous than in young people, but it is not fully appreciated that if concurrent and complicating diseases can be eliminated, aged people will tolerate operations of moderate magnitude almost as well as young people. The field of geriatric surgery is so large, and the circumstances involved in the clinical data so varied, that true values can be obtained only by summarizing a large number of articles dealing with various phases of the subject. Unfortunately, there is no uniformity in the studies found in the literature. In the first place, the age limit chosen by the various authors in their studies on surgery of the aged varies from 40 to 70 years. Although valuable information is obtainable by using different age limits as the dividing line between youth and old age, it would appear to the author that the deteriorating effects of old age do not develop significantly much before the age of 60. The fact that one of the most important known hormonal changes (the female menopause and male climacteric), occur most often between the ages of 50 and 60, would be an added reason for utilizing the age of 60 for geriatric studies. Regardless of what age is chosen as a threshold, it should be emphasized that chronological age is not a true index of functional reserve, because some people are as vigorous at 75 as others are at 60 years.

The fact that life expectancy has increased from 48 years in 1900 to 68.27 years in 1950, is ample reason for making a serious study of all aspects of geriatric surgery. This difference in longevity indicates that the number of people living past a given age has increased very significantly. For example, Groom[1] has shown that although the increase in population of the United States between 1930 and 1940 was only 7 per cent, the number of people living between the ages of 65 and 74 had increased by 35 per cent, and the number over 75 years had increased 38 per cent. Moreover, United States census figures show that if a person reaches the age of 60, his life expectancy is 76. Likewise at the age of 65 and 70, life expectancy is 78 and 80, respectively.

## PHYSIOLOGIC DIFFERENCES BETWEEN THE AGED AND YOUNG

No one can dispute the fact that as age develops, the reserve of certain organs and body functions decreases. However, we have positive proof of deficiency on comparatively few of these functions. Accordingly, many of the statements made on the physiologic differences are made with circumstantial evidence.

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We have good evidence that the elasticity of arteries and arterioles decreases with age. Accordingly, it is obvious that elderly people would be more susceptible to vascular shock (from hemorrhage, burns, etc.) than young people. Arteriosclerotic changes in the blood vessels of the kidney would likewise make the elderly patient more susceptible to renal dysfunction and the ill effects of arteriosclerotic nephritis, oliguria, etc. Degenerative vascular changes probably also explain the fact that elderly people tolerate heat and cold so poorly.

The elderly patient is more susceptible to the ill effects of hypoxia and anoxia, largely because of vascular changes in the brain, heart, etc. For this reason, the anesthetic in elderly patients becomes a very important part of the operation.

Malnutrition is more prevalent in elderly people because so many have a depressed appetite and suffer from so many dental complications that eating becomes a chore rather than a pleasure.

Of the hormonal deficiencies, the climacteric (M) and menopause (F) are the most obvious. This change may be more important in the male than in the female, because testosterone has a conserving effect on nitrogen. It is probable that functions of other organs such as the adrenal cortex are likewise impaired, but we have little proof of this. It is well known that a mild hypothyroidism is commonly present in elderly people. Depression of the bone marrow so frequently observed hematologically in elderly people may possibly be explained on hormonal deficiency.

Elderly individuals are more susceptible to infection, and tolerate infections less readily than young persons. For example, Bosch and associates,[2] noted that in 48 patients past 60 who died postoperatively following major operations, infection was the primary cause of death in 31.2 per cent of cases; eight had peritonitis, six had pneumonia, and one had septicemia. Moreover, in this series 71 per cent of all postoperative complications were due to infections, even though this study was made in patients observed from 1947 to 1949 when numerous effective antibiotics were available.

Because of the numerous deficiencies in body functions of elderly people, it is to be expected that they would have less reserve of numerous physiologic functions which protect against the damaging effect of such loads as major operations.

Although we have proof that certain body functions in elderly people are depressed, and circumstantial evidence that other functions are depressed, we have evidence (experimental and clinical) almost equal to proof, that the healing power of tissue itself is as efficient in the elderly person as in the young. Likewise we know that the body need for nitrogen is less in the aged than in the young, although this phase of nutrition is more than neutralized by the prevalence of malnutrition in the aged.

Brozeck and Keys[3] have reported that between the ages of 19 to 25 years, 9.8 per cent of the body weight is composed of fat, whereas between the age of 45 and 55 years, 21 per cent of the body weight is fat. This may not have much physiologic significance except that it does offer an explanation for Beling and associates[4] finding that the total blood volume per kilo of body weight is lower in elderly people than in young people; there may, of course, be other reasons.

## PREOPERATIVE CARE

Effective preoperative care is more important in elderly than in young individuals because (1) more physiologic deficiencies are found in the aged, and (2) they tolerate complications less readily than young people. Accordingly, a thorough examination is strongly indicated, so that the various deficiencies, if present, may be corrected.

When major operations are contemplated in elderly persons, certain chemical data in addition to the routine blood and urine examination will be necessary. Important in these data are N. P. N. and blood protein;

if loss of fluid has taken place because of vomiting, diarrhea, lack of intake, etc., sodium, potassium and chloride determinations must be obtained. All such defects should be corrected before a major elective operation is performed. In diseases of the biliary tract, liver function tests must be obtained because operability is decreased sharply by hepatic insufficiency, which at times is correctible by transfusions and treatment of malnutrition with proper oral and intravenous intake.

Perhaps the most important of all the deficiencies present in the aged patient is inadequate quantity of blood. At times this deficiency may be demonstrated by the hematocrit, hemoglobin, or red cell count. More commonly the blood lack will not be evident by the usual hematocrit or hemoglobin determinations, but can be discovered only by blood volume determinations; on many occasions dehydration may result in so much hemoconcentration that a normal hemoglobin and hematocrit is present even though a serious anemia may actually be present. We emphasize again that even in the presence of normal hydration, with normal hematocrit and hemoglobin values, a marked deficiency in blood volume may exist which can be detected only by blood volume determination, as has been emphasized by Beling and associates,[4] and numerous other observers.

Since cardiac disease is very common in elderly people and is also a common cause of death postoperatively, the cardiac status must be determined. The EKG is of comparatively little value except in detection of a recent coronary occlusion. It is well known that major operations may be toler-

TABLE I. *Mortality Rates in Major Operations, Comparing Patients Under 60 with Patients Over 60.* (Illinois Research Hospital 1948–1952)

| Operation | Under 60 Years | | | Over 60 Years | | | |
|---|---|---|---|---|---|---|---|
| | No. of Cases | No. of Deaths | % Mort. Rate | No. of Cases | No. of Deaths | % Mort. Rate | Mort. Rate All Ages |
| Abdominal Exploration | 95 | 4 | 4.2 | 44 | 1 | 2.3 | 3.6% |
| Amputation | 59 | 0 | 0 | 20 | 0 | 0 | 0% |
| Appendectomy | 64 | 0 | 0 | 5 | 0 | 0 | 0% |
| Breast, Radical | 122 | 0 | 0 | 67 | 0 | 0 | 0% |
| Cholecystectomy | 169 | 0 | 0 | 54 | 1 | 1.8 | 0.4% |
| Choledochoplasty | 44 | 1 | 2.3 | 12 | 1 | 8.3 | 3.7% |
| Choledochostomy | 41 | 0 | 0 | 10 | 1 | 10.0 | 2.0% |
| Colectomy | 43 | 2 | 4.6 | 26 | 2 | 7.7 | 5.7% |
| Colostomy | 53 | 1 | 1.9 | 36 | 3 | 8.3 | 4.5% |
| Esophagectomy | 17 | 5 | 29.4 | 31 | 13 | 41.9 | 37.5% |
| Gastrectomy for Cancer | 34 | 2 | 5.8 | 36 | 1 | 2.8 | 4.3% |
| Gastrectomy for Ulcer | 67 | 1 | 1.5 | 24 | 0 | 0 | 1.1% |
| Gastroenterostomy | 26 | 1 | 3.8 | 29 | 0 | 0 | 1.8% |
| Gastrostomy | 36 | 5 | 13.9 | 59 | 2 | 3.4 | 7.3% |
| Intestinal Obst | 25 | 2 | 8.0 | 7 | 1 | 14.4 | 9.4% |
| Herniorrhaphy (all types) | 313 | 1 | 0.3 | 68 | 1 | 1.5 | 0.5% |
| Lobectomy (Lung) | 86 | 2 | 2.3 | 8 | 0 | 0 | 2.1% |
| Oral and Neck Radical | 105 | 1 | 1.0 | 121 | 14 | 11.5 | 6.6% |
| Plastic Major | 61 | 0 | 0 | 10 | 0 | 0 | 0% |
| Pneumonectomy | 49 | 6 | 12.2 | 18 | 5 | 27.7 | 16.5% |
| Rectum (Rad. Res.) | 53 | 0 | 0 | 62 | 8 | 11.7 | 6.9% |
| Splenectomy | 41 | 2 | 5.0 | 5 | 0 | 0 | 4.3% |
| Sympathectomy | 181 | 0 | 0 | 39 | 1 | 2.5 | 0.4% |
| Thoracic Exploration | 50 | 3 | 6 | 29 | 2 | 6.8 | 6.3% |
| Thyroidectomy | 287 | 0 | 0 | 44 | 0 | 0 | 0% |
| Urologic | 160 | 2 | 1.2 | 133 | 1 | 0.8 | 1.0% |
| Vascular | 62 | 7 | 11.3 | 1 | 1 | 100 | 12.7% |
| Miscellaneous | 214 | 4 | 1.8 | 81 | 7 | 8.6 | 3.6% |
| Total | 2,557 | 53 | 2.07 | 1,099 | 56 | 5.1 | 2.95% |

ated quite well, providing at least three months have elapsed since the occlusion. Cardiac reserve may be estimated by obtaining answers to certain questions related to ankle edema, dyspnea, orthopnea, walking limit, stair climbing and exercise pain (*i.e.* anginal). Contrary to the opinions of many observers, repletion of blood in cardiac disease must be carried out, and is just as important as in any other chronic disease associated with blood loss. In fact, Beling and associates conclude that blood repletion "is not only safe for patients with cardiac disease, it is mandatory."

Emphysema and other chronic pulmonary diseases are so common in elderly people, that a thorough assay of pulmonary reserve is essential before a major operation is performed. Determination of vital capacity is very informative from the prognostic standpoint, and is not utilized as much as it should be.

Hormonal therapy may be very helpful in improving operability. In elderly debilitated men, testosterone often eradicates such complaints as weakness, anorexia, diffuse pain, etc. Still more important in improving operability in certain conditions are ACTH and Cortisone.[5, 6] Figure 1 illustrates how ACTH almost certainly converted inoperability in an old man age 71 with a bronchiogenic carcinoma, to a status of operability. Perhaps the most important beneficial effects of ACTH and cortisone are the production of a ravenous appetite, elimination of fever with its deleterious effects, and stimulation of the desire to be up and about. A sharp weight gain is always noted, but much of this is no doubt water. Although ACTH is very valuable in improving operability, it must be emphasized that if these drugs (particularly cortisone) are given over a long period of time, so much adrenal atrophy may be produced that an irreversible shock may develop after a major operation. To improve operability, we give ACTH in a dose of 100 mg. per day for five to six days, before operation. It may likewise be given a few days postoperatively.

TABLE II. *Mortality Rate Following Major Operations Showing no Significant Difference in Young and Elderly Patients.*
(Illinois Research Hospital 1948–1952)

| Operation | Under 60 Years | | | Over 60 Years | | |
|---|---|---|---|---|---|---|
| | No. of Cases | No. of Deaths | % Mort. Rate | No. of Cases | No. of Deaths | % Mort. Rate |
| Breast, radical | 122 | 0 | 0 | 67 | 0 | 0 |
| Cholecystectomy | 169 | 0 | 0 | 54 | 1 | 1.8 |
| Colectomy | 43 | 2 | 4.6 | 26 | 2 | 7.7 |
| Gastrectomy | 101 | 3 | 3 | 60 | 1 | 1.6 |
| Herniorrhaphy (all types) | 313 | 1 | 0.3 | 68 | 1 | 1.5 |
| Thyroidectomy | 287 | 0 | 0 | 44 | 0 | 0 |

It is now well known that when a patient is bedfast, muscles become atrophic, but more important, a negative nitrogen balance ensues; these facts are not fully appreciated. The elderly patient is usually very content to stay in bed and rest comfortably; unless the clinician or nursing staff makes a special point of maintaining preoperative ambulation, maximum operability may not be achieved. Although preoperative ambulation is important, it is just as important that unnecessary examinations such as barium enemata, etc., not be carried out, particularly if the patient is quite ill; in such patients we must eliminate needless manipulation.

Procrastination and postponement of elective operations is a common error in the treatment of elderly patients. As will be emphasized later, an elderly patient free from concurrent disease or complication will tol-

erate the average major operation almost as well as a young person, but he tolerates emergency operations very poorly. Too often, surgical therapy for elective conditions is postponed in elderly patients, in the hope, I presume, that the patient will die of some other disease before the present one threatens his life. Cholelithiasis with mild symptoms is a common example of a lesion which may give rise to a more complicated condition (*e.g.*, stone in the common duct), or emergency situation (*e.g.*, perforation of the gallbladder), if it is allowed to remain untreated.

TABLE III. *Mortality Rate Following Major Operations Showing Higher Mortality Rate in Elderly Patients Than Young Patients.*
(Illinois Research Hospital 1948–1952)

| Operation | Under 60 Years | | | Over 60 Years | | |
|---|---|---|---|---|---|---|
| | No. of Cases | No. of Deaths | % Mort. Rate | No. of Cases | No. of Deaths | % Mort Rate |
| Colostomy | 53 | 1 | 1.9 | 36 | 3 | 8.3 |
| Esophagectomy | 17 | 5 | 29.4 | 31 | 13 | 41.9 |
| Oral and Neck (radical) | 105 | 1 | 1.0 | 121 | 14 | 11.5 |
| Pneumonectomy | 49 | 6 | 12.2 | 18 | 5 | 27.7 |
| Rectum (rad. exc.) | 53 | 0 | 0 | 62 | 8 | 11.7 |
| Miscellaneous | 214 | 4 | 1.8 | 81 | 7 | 8.8 |

### ANESTHESIA AND THE OPERATION

It is agreed by almost all who have given considerable thought to anesthesia in the aged that the presence of a good anesthetist is more important than the choice of anesthetic agent. Nevertheless, a few general principles may be offered. For example, whenever regional local anesthesia is possible, it should be utilized. Spinal anesthesia would appear to be appropriate in patients with pulmonary complications, but it should be remembered that in the presence of arteriosclerotic hypertension, a spinal anesthetic may be undesirable, particularly since even brief periods of lowered pressure may result in hypoxia, oliguria, etc. Since elderly people tolerate hypoxia poorly, effort must be made to choose the agent which will allow maximum oxygenation and still obtain satisfactory anesthesia. In general, nitrous oxide and ethylene do not allow sufficient oxygenation. Cyclopropane can be given, along with a very high percentage of oxygen, but in certain heart complications it may be dangerous. Nevertheless, this danger has been exaggerated. Actually there are very few cardiac lesions which are made worse by cyclopropane; cardiac block is an example of one which may give rise to complete stoppage if cyclopropane is given. Pentothal is satisfactory for a short minor procedure, but is too depressing to be used over a long period of time for a major operation. The dose of premedicating drugs should be much less (perhaps half) in elderly patients than in husky young patients.

A few general principles in *operative technic* must be adhered to. Ordinarily the operative time is of little consequence, but in elderly patients it is important to complete the operation in the shortest time possible. Careless technic and rough handling of tissue is not tolerated well by elderly patients. In general, application of tourniquets to extremities is undesirable, because arteriosclerotic arteries may be damaged or veins traumatized, perhaps with increased tendency toward phlebothrombosis. Since physical reserve is often minimal in elderly people, the patient's condition should be followed closely at all times during the operation; the surgeon should be prepared to choose a shorter procedure, or perhaps adopt a stage procedure if the patient's con-

dition should deteriorate significantly during the operation. Accurate blood replacement at the operation table is particularly important in elderly patients.

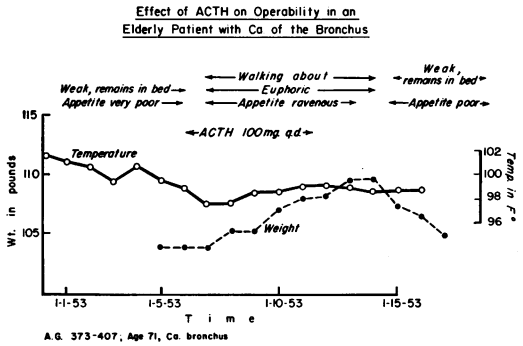


FIG. 1. Due to disease, malnutrition and hormonal defects, many elderly patients are such poor risks that a major operation will not be tolerated. The patient illustrated above was 71, and had a carcinoma of the lung. His condition was so poor that his chance of surviving operation appeared to be zero. ACTH resulted in remarkable improvement. Another course of ACTH (just before operation) was given after termination of the above graph; his postoperative convalescence was uneventful.

### POSTOPERATIVE TREATMENT

Because of the tendency for elderly people to develop "moist" lungs, it is essential that an excess amount of fluid not be given; in fact, it is desirable to give less fluid than to the young patient, although accurate blood replacement must be achieved. Since the aged kidney is more susceptible to oliguria, and less able to secrete concentrated urine, intravenous fluid given during the first 24 hours should contain no salt.

Since elderly patients are prone to develop pulmonary complications, it is essential that deep breathing exercises be faithfully carried out, the patient made to cough, and encouraged to move about in bed every hour or two while awake. If there is evidence of atelectasis and the patient is too weak to cough up mucous, or for other reasons is unable to do so, the trachea and bronchi should be aspirated with tube suction. If there is positive evidence (*e.g.* by roentgenogram) that atelectatic lung is not being eradicated by the mechanisms mentioned above, actual bronchoscopy may be indicated. If mucous continues to accumulate and cannot be evacuated by aspiration, it is often desirable and even life saving to do a tracheotomy, which allows frequent and effective aspiration. Oxygen therapy (preferably by intranasal tube) is strongly indicated if there is the slightest evidence of cardiac embarrassment or restriction of pulmonary function by atelectasis, etc.

As mentioned previously, early ambulation may be very important in prevention of certain complications such as phlebothrombosis, atelectasis, etc. However, this therapy is often abused. Ambulation is contradindicated in numerous conditions such as cardiac decompensation, extreme weakness, peritonitis, hemorrhage, fever and recent thrombophlebitis or phlebothrombosis. Tight binders to the thorax or abdomen should be avoided. Postoperative sedatives should be given sparingly to elderly patients, partly because they are more susceptible to such drugs.

Malnutrition is very prevalent in elderly patients. Accordingly, all effort should be made to start oral intake after major operations as soon as possible. In mal-nourished gastrectomy we utilize early postoperative feedings by means of an Abbott-Rawson tube, which allows one to decompress the stomach and feed into the jejunum.

An important precaution not fully appreciated in elderly patients is the prevention of aspiration of gastric contents into the lungs. Until consciousness is fully regained from the anesthetic, the patient should be turned on his side, or have an attendant constantly at the bedside to prevent this serious complication.

### ANALYSIS OF MORTALITY RATE IN 3656 MAJOR OPERATIONS AT ILLINOIS RESEARCH HOSPITAL

We have made a study of major operations (all charity patients) performed at Illinois Research Hospital during a five-year period (1948 to 1952 inclusive), in an effort to determine primarily the mortality rate

of patients under 60 years of age as compared to the rate in patients past 60. We have obtained data on numerous individual types of operations, but have limited our study to patients in our own department having abdominal, thoracic, vascular, plastic, urologic, breast, extremity and neck operations (as illustrated in Table I), but excluding orthopedic, obstetric, gynecologic, otolaryngologic and ophthalmologic operations. This limitation of operations to those performed by one staff was made so that we could maintain uniformity, and thus minimize the possible erroneous influence of variations in postoperative care on our statistical data.

There is no sharp dividing line between major and minor operations, but we have classified radical excision of the breast, thyroidectomy and herniorrhaphy as major operations; all types of herniorrhaphy such as inguinal, femoral, diaphragmatic, ventral and umbilical have been included. To avoid the possible erroneous influence of congenital malformation of infancy, we have excluded all infants or children under two years of age. Most of the abdominal and thoracic explorations consist of operations for inoperable carcinoma; likewise most of the colostomies and gastrostomies were performed for inoperable carcinoma. The vast majority of lobectomies (lung) were performed for bronchiectasis. Almost all of the "oral and neck radical" operations were for carcinoma. Only the more extensive plastic operations were included, representing only a small portion of procedures performed by the plastic surgeon. Of the "urologic" operations, we have excluded all transurethral procedures, but have included suprapubic and retropubic prostatectomies. The "miscellaneous" group includes entero-enterostomies, incision of abdominal abscesses, operations for perforated viscera, resection of small intestine for neoplasms, pancreatectomy and numerous other infrequent abdominal operations more extensive than exploration alone.

A study of comparative figures (*i.e.*, for patients under 60 and over 60 years of age) in the various types of operations reveals no difference in some procedures and a marked difference in others. In operations having a very low mortality rate (*i.e.*, under 1 or 2 per cent), it is obvious that data would not be significant unless the number of operations approached 1,000 or more. Likewise, in many operations, it would appear that the operative load is too light to reflect a difference in the mortality rate in the two groups; actually most of the operative procedures in Table II (as well as many others in Table I) belong in this category. Although gastrectomy is definitely a major operation, it now appears that with our improved preoperative and postoperative care, the operative load is not sufficient to reflect a difference in the two age groups. As has been noted by others, our mortality rate following gastrectomy for cancer is considerably higher in gastrectomy for cancer than it is in gastrectomy for ulcer, being 4.3 per cent in the former and 1.1 per cent in the latter lesion. The mortality rate of 4.6 per cent in patients under 60 having colectomy is considerably lower than the figures of 7.7 per cent in patients over 60 years of age. The series, however, is too small for this difference to have statistical significance. Perhaps of more importance is the fact that the two deaths in the colectomy group under 60 occurred in patients with benign lesion (one following resection for colitis, the other following resection for a vesicocolic fistula, and not cancer. The two deaths in the group over 60 years of age

TABLE IV. *Summary of Mortality Rates Following Major Operations in Young and Elderly Patients.* (Illinois Research Hospital, 1948–1952)

| | No. of Cases | No. of Deaths | % Mort Rate |
|---|---|---|---|
| Under 60 years | 2557 | 53 | 2.07 |
| Over 60 years | 1099 | 56 | 5.1 |
| Total | 3656 | 109 | 2.95 |

occurred in patients with cancer of the colon.

In Table III are listed several types of operations which show the mortality rate in the elderly group to be markedly higher than in the young group. With the exception of one (colostomy), all of these represent operations which are sufficiently formidable to influence the rates between the two age groups on the basis of strain on physical reserve. One of the most striking differences is encountered in radical oral and neck resection; this difference appears particularly significant since there are over 100 cases in each of the two age groups, and the mortality rate was only 1 per cent in patients under 60, whereas it was 11.5 per cent in those over 60. A marked difference might be expected in this category because the advanced stage of disease as noted in our patients (all of which are charity) exerts a markedly deleterious effect on the nutritional status of the patient, since chewing and swallowing are so much impaired in elderly patients with cancer about the oral cavity.

As would be expected in comparatively small individual series, the mortality rate is higher than expected in some types of operations, and lower in others. Our mortality rate in esophagectomy is high in both age groups (29.4 per cent in patients under 60, and 41.9 per cent in patients past 60) than might be expected, but under average in such groups as radical excision of the breast, amputation, thyroidectomy and appendectomy. There were no fatalities in any of the four latter groups just mentioned. Perhaps the only unexpected result occurred in the gastrectomy group; the mortality rate in gastrectomy for cancer as well as benign ulcer was higher in patients under 60 (5.8 and 1.5 per cent respectively) than in patients over 60 years of age (2.8 and 0 per cent respectively). Combining the malignant and benign lesions, the mortality rate for gastrectomy in 101 patients under 60 was 3 per cent compared to 1.66 per cent in 60 patients over 60 years of age. We have no explanation for this discrepancy other than an unusual coincidence in a relatively small series. Our total series is large enough to yield results which should certainly eliminate even an unusual coincidence.

Table IV represents a summary of all of our cases studied. In 2,557 major operations in patients under 60 years of age, the mortality rate was 2.07 per cent compared to a rate of 5.1 per cent in 1,099 patients over 60. The mortality rate for all ages (excluding infants and children under two years of age) was 2.95 per cent. Therefore, it appears safe to conclude that if the operative load is severe enough, the mortality rate will be two to three times higher in patients over 60 than in patients under 60 years of age.

TABLE V. *Mortality Rates for All Diseases.**

| Author | No. of Pts. Past 60 | Mortality Rate Over 60 | Mortality Rate All Ages |
|---|---|---|---|
| Estes | 400 | 6.5% | 2.1% |
| Bosch et al | 500 | 9.6% | 3.01% |
| Cole | 3656 | 5.1% | 2.9%† |
| Carp | 851 | 17.0% | (all indigent 24% were emergencies) |
| Haug & Dale | 354 | 9.0%‡ | |

*The operations in all 5 series were major except 14% minor in Estes' series.

†Mortality rate 2.07% under 60 years.

‡In Haug and Dale's series mortality rate was 4.1% in private pt's and 13.5% in ward pt's.

TABLE VI. *Mortality Rate in Specific Diseases or Operations.*

| Disease | Author | Age of Series and Mort. Rate |
|---|---|---|
| Int. Obst. | Cutler | 53% over 60 yrs.; |
| Appendicitis | Wolff & Hindman | 4.5% over 60 yrs.; 0.7% in 30 to 40 yrs. |
| Bil. Tr. Ops. (Benign) | Gaster | 5.8% over 50 yrs.; 0.6% under 50 yrs. |
| Choledochostomy. | Glenn | 9.6% over 50 yrs.; 1.5% under 50 yrs. |
| Op. for Acute Cholecystitis | McLanahan | 26.5% over 60 yrs.; 2.85% under 60 yrs. |
| Gastrectomy for benign ulcer | Stewart et. al | 1.62% over 50 yrs.; 1.25% under 50 yrs. |

MORTALITY RATES SUMMARIZED FROM THE LITERATURE

*(For all diseases combined)*

In a series of 400 consecutive operations (1943 to 1948), all of which were major, except 14 per cent, Estes[7] noted a mortality rate of 6.5 per cent in patients over 60, and 2.1 per cent in patients under 60 years of age (Table V). All operations in his series were either in the field of general surgery or gynecology. Only 10 per cent were emergencies.

TABLE VII. *Mortality Rate of Aged in Emergency Operations as Compared to Elective Operations.*

| Author | Mortality Rate in Emerg. Op's | Elective Op's |
|---|---|---|
| Estes | 16.4% | 5% |
| Haug & Dale | 21.9% | 5.7% |
| Bosch et. al. | 17.4% | 8.8% |
| Average | 17.0% | 6.1% |

In 500 major operations observed (1947 to 1949) in patients 60 or more years of age, Bosch and associates[2] noted a mortality rate of 9.6 per cent as compared to a rate of 3.01 per cent in patients under 60 years of age. Various specialties including general surgery, gynecology, urology and orthopedics were included in this series. Slightly over 9 per cent were emergencies. Very important in this study is the fact that in patients without concurrent disease the mortality rate was 6.6 per cent, whereas in patients with concurrent disease the rate was 12.3 per cent, thus indicating the great importance of eliminating all complicating diseases possible.

In 354 major operations in the field of general surgery alone (1950 to 1951), Haug and Dale[8] noted a mortality rate of 9 per cent in patients past 60. In this group of operations 20 per cent were emergencies. Very significant in this study is the fact that the mortality rate was 4.1 per cent in private patients and 13.5 per cent in ward (charity) patients. This sharp differential in the mortality rate of private versus ward patients has been noted by other observers.

In a series of 851 major operations (1945 to 1949) in patients past the age of 60, Carp[9] reported a mortality rate of 17 per cent. Twenty-four per cent of these operations were emergencies. This high percentage of emergency cases, coupled with the fact that all the patients were derived from a chronic disease hospital, is sufficient to explain the unusually high mortality rate in his series.

MORTALITY RATES SUMMARIZED FROM THE LITERATURE

*(For specific diseases)*

In a study of mortality rate in patients past the age of 60, having operation for intestinal obstruction, Cutler[10] encountered a rate of 55 per cent in 56 indigent cases from a "chronic" hospital, and 53 per cent in 63 patients from Roosevelt Hospital, New York (Table VI).

In appendicitis, Wolff and Hindman[11] noted a mortality rate of 4.5 per cent in 88 patients past 60 years of age, compared to a rate of 0.7 per cent for patients between 30 and 40 years. Also significant in this study is the fact that 58 per cent of the patients past 60 had a perforated appendix. It is well known that acute inflammatory lesions like appendicitis may progress with minimal manifestations in elderly patients.

In 550 operations on the biliary tract in patients past 50 years of age, reported by Gaster,[12] the mortality rate was 5.8 per cent, whereas it was only 0.6 per cent in the control patients under 50. Similar findings were encountered by Glenn,[13] who reported a mortality rate of 9.6 per cent in patients past 50 having choledochostomy during the years 1932 to 1950, whereas the rate was 1.5 per cent in patients under 50. Of significance in this series is the fact that of 10 deaths occurring in patients past 59, three died of peritonitis, whereas none of the patients under 59 died of peritonitis; this indicates, as is fairly well recognized, that

elderly people are very susceptible to peritonitis. McLanahan and associates[14] noted a mortality rate of 26.5 per cent in 140 patients having operation for acute cholecystitis during the years 1923 to 1940; in patients under 60 the mortality rate for these operations was only 2.85 per cent. It will be noted from data presented above that the difference between the mortality rate of the young and aged in operations on the biliary system is very marked.

In 203 consecutive gastrectomies for benign ulcers (excluding those with acute hemorrhage), reported by Stewart and associates,[15] the mortality rate in patients under 50 was 1.25 per cent, compared to 1.62 per cent in patients over 50. This difference is so slight that it is scarcely significant statistically. This report coincides with our data revealing no significant difference in the mortality rate from gastrectomy in the young and aged.

Differences in the mortality rate of emergency operations and elective operations is quite marked, as illustrated in Table VII; the average mortality rate in the three series was 17.0 per cent for emergency operations, as compared to 6.1 per cent in elective operations. Not included in this series is data reported by Carp in patients past 60 showing a mortality rate of 44 per cent in the years between 1939 and 1944, and 39 per cent in the years between 1945 and 1949. These figures of Carp are so much higher than those of other observers that they have not been averaged in with the series of emergency operations. The explanation for his high figures probably lies in the fact that all of the patients were indigent from a chronic disease hospital. The above data strongly suggests that emergency operations are poorly tolerated by elderly people. With these data we should include the results of a study made by Collins[16] in Los Angeles County Hospital. He noted that the mortality rate in acute abdominal injuries was practically the same in patients under 40 as in patients over 40. However, it would appear that age 40 is too young to be used as a threshold between elderly and young patients.

### CAUSES OF POSTOPERATIVE DEATHS IN ELDERLY PATIENTS

In Table VIII are listed the most common causes of death in three reports devoting special attention to this phase of geriatric surgery. It will be noted that the figures for the various causes in the three series are in remarkedly close agreement. As might be expected, cardiac disease was the most common cause in all three series, with an average figure of 22 per cent. Next in order of frequency are pneumonic complications (pneumonia and/or atelectasis), peritonitis, pulmonary embolism and renal failure. Although cardiac disease is perhaps the most common cause of death postoperatively in elderly patients, its presence preoperatively is by no means a hopeless sign. In the report of Bosch and associates,[2] the diagnosis of cardiac disease was made preoperatively in 226 of the 500 patients having major operations; only ten of these patients died from heart disease following operation.

TABLE VIII. *Causes of Post Op. Deaths in Aged.*

| Diagnosis | Author Bosch et. al. | Carp | Haug & Dale | Average |
|---|---|---|---|---|
| Cardiac failure..... | 21% | 30 | 16% | 22% |
| Pneum. (and atel.)..... | 10% | 28 | 10% | 16% |
| Peritonitis..... | 17% | 18 | 3% | 13% |
| Pul. embolism..... | 10% | 7 | 16% | 11% |
| Renal failure..... | 14% | 6 | 3% | 8% |

58% (Bosch et. al) had Ca.
22% (Haug & Dale) had inoperable Ca.
Average Bl. vol. deficit (Bosch et. al.) 1240 cc.

Beling and associates[4] have presented convincing evidence that failure to replace a depleted blood volume is a serious error of omission in elderly patients. For example, in 190 elderly patients who did not have blood volume studies and were given blood according to the usual bedside indications before their major operation, the postoperative mortality rate was 17.4 per cent, com-

pared to 8.0 per cent in 100 elderly patients who had blood volume studies and sufficient blood before operation to restore the calculated blood volume to a "normal mean" (85 ml. per Kg.). The average amount of blood given in the first group was 750 cc. compared to 1500 cc. in the second group. Perhaps of still more importance in their study is the fact that the death rate from cardiac failure in the patients without adequate blood volume repletion was 5.2 per cent, whereas none died from cardiac failure in the 100 patients having blood repletion with an amount indicated by blood volume studies. Moreover, three deaths in the 190 patients not having adequate blood replacement were listed as due to postoperative shock, whereas none of the 100 patients receiving adequate blood replacement before operation died of shock. Another important point in lethal complications is the fact that in Carp's[17] study of causes of deaths in 100 consecutive deaths following gastro-intestinal operations, 55 per cent of the patients dying following gastro-intestinal operations succumbed to peritonitis. This study was made in patients observed from 1939 to 1947; since a large portion of this period was before the time of the most effective antibiotics, it is probable that the incidence of peritonitis might be less now. Other important causes of death were hepatic insufficiency, cerebrovascular accidents, sepsis and postoperative shock.

Very significant is the fact that in the series reported by Bosch and associates,[2] 58 per cent of the patients dying following operation had carcinoma. Haug and Dale[8] noted that in 22 per cent of their deaths, inoperable carcinoma was present.

Of the complications developing after major operations on elderly patients, pulmonary complications consisting primarily of atelectasis are the most common. Haug and Dale[8] found that these complications constituted 24.6 per cent of all complications occurring in their series. Next in order of frequency in their series were urinary complications and infections with a frequency of 13.8 and 7 per cent, respectively.

## COMMENT

A study of statistical data leads one to the rather obvious conclusion that the over-all mortality rate in elderly patients is distinctly higher than in young patients. However, it is likewise obvious that if the operative load (even though a major operation) is within certain limits and the patient is free from concurrent disease, the mortality rate may not be higher than in young people, providing all decrements or insufficiencies are met before operation, and providing excellent postoperative care is carried out. An excellent example of equality in postoperative mortality rate is the study made by Stewart and associates[15] in which a mortality rate of 1.25 per cent was encountered in patients under 50 years having gastrectomy for ulcer (excluding those with hemorrhage), as compared to 1.62 per cent in patients over 50 years of age. Our own experience (Table II) likewise reveals that in major operations of the less formidable type, there may be no difference in the mortality of the young and aged; in our series, the mortality following gastrectomy was not significantly different in the two age groups, thus conforming to the findings of Stewart and associates; it was actually higher in patients under 60 compared to those over 60 years of age, but the series was small (Table I).

All clinicians have noted that if elderly patients are not afflicted with complications after operation, they will survive massive operations, although accurate blood replacement is essential. To a certain extent the presence of concurrent disease exerts the same deleterious effect on postoperative survival as do complications, as indicated by a postoperative mortality rate in patients past 60 or 6.6 per cent in those without concurrent disease compared to 12.3 per cent in patients with concurrent disease (Bosch and associates[2]).

With one exception (Collins[16]), all studies coming to the present author's attention reveal a poor tolerance of emergency operation by elderly patients as summarized in Table VII; in three reports (Table VII), the mortality rate following emergency operations on elderly patients was 17 per cent, as compared to 6.1 per cent in elective operations. Perhaps the greatest difference in postoperative mortality rate of elderly versus young patients is found in operations on the biliary tract as indicated in Table VI. In one series (Gaster[12]) consisting of all types of operations on the biliary tract, the mortality rate was ten times greater in patients past 50; in another series past 50, having choledochostomy (Glenn[14]), it was six times greater than in patients under 50; in another series of operations for acute cholecystitis (McLanahan[14]), it was ten times greater in patients past 60 than in patients under 60. These differences are so striking that they cannot be ignored.

However, this difference in the two age groups of the three series of biliary tract operations just mentioned is not sustained in our series of cholecystectomies, although it is sustained if cholecystectomies, choledochostomies and choledochoplasties are combined. The total mortality rate of the three operations in our series just mentioned is 0.39 per cent in patients under 60, compared to 3.9 per cent in patients past 60 years of age. It appears likely that cholecystectomy is not sufficiently formidable in the late years of improved pre and postoperative cases when our series was accumulated, to reflect a difference in the two age groups. However, it is well known that impaired liver function is very common in patients having choledochoplasty and choledochostomy; it would appear that the improvement of knowledge during recent years is not adequate to erase the ill effects of this impaired liver function.

In 211 deaths following 5,152 operations (presumably of major and minor types), Bruce[18] noted that 62 per cent occurred in patients past 60, and 37 per cent in patients past 70 years of age. In his series, 48.2 per cent of the deaths were the result of malignant diseases.

Certain precautions are very important in influencing mortality rates. In the first place, elderly patients are more apt to aspirate gastric content while convalescing (particularly while coming out of the anesthetic) because their gag reflex is less active; moreover, they are particularly apt to suffer deleterious effects from aspiration because they do not have the strength to cough effectively, and are prone to development of pneumonic complications. To prevent pulmonary complications, the most common of which is atelectasis, it is necessary that deep breathing exercises be carried out, and the patient encouraged to cough every hour or two. It is often necessary to aspirate the trachea by means of a nasal tube; if the plug producing the atelectasis is not removable by aspiration, bronchoscopy may be necessary. If bronchial obstruction recurs and the patient is quite weak, emergency tracheotomy may be required to allow frequent aspiration through the tracheotomy tube, especially in patients having esophagectomy.

Ambulation is effective in encouraging pulmonary expansion and aeration, and in increasing circulation. Statistics show that the former diminishes pulmonary complications, and the latter decreases the incidence of phlebothrombosis and pulmonary embolism. However, by no means does ambulation obliterate these complications. Even though it is agreed that ambulation decreases the incidence of numerous complication, it is often abused in elderly people, because it is so frequently contraindicated. For example, ambulation is contraindicated in cardiac decompensation, extreme weakness, high fever, peritonitis, and on other occasions when the patient is critically ill.

SUMMARY

Evidence is rapidly accumulating to the effect that the mortality rate in major operations of slight magnitude are tolerated about as well by elderly patients as by young patients. On the other hand, in the operations of greater magnitude the mortality rate in the elderly group may be two to four times higher than in the young group. Likewise there is fairly concrete evidence that concurrent or complicating diseases will elevate the mortality rate following major operations much more in elderly than in young patients. A survey of reports from the literature indicates that the mortality rate of emergency operations in the aged is markedly higher than in elective operations (18.6 per cent compared to 6.5 per cent respectively, as illustrated in Table VII).

In an analysis of 3,656 major operations performed by the general surgical service at Illinois Research Hospital between 1948 and 1952 inclusive, the initial statement in the preceding paragraph is corroborated insofar as the mortality rate for operations such as radical breast, cholecystectomy, gastrectomy, herniorrhaphy and thyroidectomy is no higher in patients over 60 than in patients under 60 years of age (Table II). On the other hand, in operations with greater magnitude, including esophagectomy, pneumonectomy, and radical excision of the rectum, the difference in mortality rate between the two age groups is very striking (Table III). There was also a marked increase in the mortality rate of radical operations for lesions (mostly cancer) about the mouth and neck in the elderly group over the rate for the young group. Although these operations could perhaps not be classified as a major operation of great magnitude, it is very probable that the malnutrition so prevalent in the aged patients having this particular lesion is an exceptionally important factor in determining mortality rate.

Summarizing our entire experience, we noted that the mortality rate in 2,557 operations in patients under 60 was 2.07 per cent compared to 5.1 per cent in 1,099 patients over 60 years of age.

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