FACTORS AFFECTING SURVIVAL OF THE GERIATRIC PATIENT AFTER MAJOR SURGERY

U AUBRY, M D , R DENIS, M D , M KEÉRI-SZANTO, M D , AND M PARENT, M.D *

IT IS HARDLY NECESSARY to emphasize to our readers the extent to which anaesthetists and surgeons in major hospitals find themselves preoccupied with the problems and challenges of surgery in the geriatric patient. Not only is the number of older surgical patients growing, but usually these subjects are graver risks than those in the younger age groups, and they demand a disproportionate share of everybody's attention. A survey of reports in the recent literature (Table I) comprising cases of about four thousand patients from around the world reveals that their problems are still largely unsolved and that elderly patients requiring major surgery continue to face a considerable risk to their lives.

Since there are few comprehensive patient groups with such a high base-line mortality, we considered the geriatric patient population to be ideally suited for a study of the effect of various parameters on survival.

TABLE I
WORLDWIDE EXPERIENCE WITH MAJOR GERIATRIC SURGERY

REFERENCE	YEAR	CASES	AGE	COUNTRY	MORTALITY %	REMARKS
1	1957	450	65 +	AUSTRIA	23	BILIARY SURG ONLY
2	1958	307	65 +	USA	17	ABD SURGERY ONLY
3	1957	464	70 +	SWITZERL	20	MAINLY ABDOMINAL SURGERY
4	1961	64	70 +	USA	7	BILIARY SURGERY ONLY
5	1961	600	70 +	USA	21	MAJOR SURGERY ONLY
6	1961	700	70 +	GERMANY	14	MAJOR SURGERY ONLY
7	1961	71	70 +	USA	24	MAJOR ABD SURGERY ONLY
8	1964	342	70 +	CANADA	13	MAJOR ABD SURGERY ONLY
9	1964	281	70 +	USA	26	BILIARY SURGERY ONLY
10	1964	395	70 +	ENGLAND	26	EMERGENCY ADMISSIONS ONLY
11	1964	500	80 +	USA	20	ALL SURGICAL ADMISSIONS

AVERAGE 379 20

*RE-CALCULATED FROM THE AUTHOR'S DATA

*The authors are from the Departments of Anaesthesia and Surgery, Université de Montréal, and Notre-Dame Hospital, Montréal, Canada. Parts of this study were presented by the senior author (M K-Sz) in a panel discussion of neuroleptanalgesia at the Third World Congress of Anaesthesiologists, Sao Paulo, September 1964, and before the Annual Meeting of the Royal College of Physicians and Surgeons of Canada, Toronto, January 1965.

MATERIAL AND METHODS

The terms "geriatric," "major surgery," and "survival" must be defined because they assume different meanings for different authors. Our population consists of patients past their 70th birthday who were anaesthetized for longer than three hours, regardless of the nature of surgery, or who had an exploration (as opposed to simple opening) of the abdomen, thorax, or skull, regardless of the length of operation. A patient was deemed to survive only if he was discharged from hospital. This is a particularly severe restriction in this age group, since many of our patients had to be retained for terminal care of their illness who, if younger, would have preferred to return to their families.

RESULTS

During the years 1963-64, more than 35,000 operations were performed at Notre-Dame Hospital. In round numbers, 5 per cent of all admissions to the surgical services (General Surgery, Neuro-Surgery, Gynecology, Urology, Oto-Rhino-Laryngology, and Ophthalmology) were in the geriatric age group, yet only 313 operations qualified for inclusion in this study. The operations were performed on 302 patients—7 patients were operated on twice and 2 others, three times. Forty patients did not survive, including one who was operated on twice—an over-all mortality of 13.2 per cent when referred to patients, or 12.8 per cent when referred to operations. The deaths account for roughly 10 per cent of the services' total mortality and for 45 per cent of the geriatric mortality. This population will be studied in finer detail.

The monthly trend in operations and the attending mortality (Fig 1) indicates that the number of operations has been rising steadily during the observation period. This rise occurs at a rate about twice that of other operations performed

FIGURE 1 Monthly trend of operations and their mortality, 1963-64. Solid line: Number of major geriatric operations each month with the best-fitting straight line calculated from these data. Broken line: the number of deaths arising from these operations.

in the hospital. We conclude that even during such a short interval the indications for surgery in the geriatric group have been widened, and that consequently, the average patient we see today is a slightly poorer risk than the patient we saw at the beginning of this study. With this in mind we can turn our attention to the trend of mortality during the same period. Since the number of deaths per month is small, the computation of the best-fitting straight line to these values is associated with so large a coefficient of variability that it cannot be meaningfully compared with the trend line of operations. It can be seen, however, that the mortality rates keep essentially steady in the face of the rising number of operations and the increasing surgical risk status of our patients.

The age of patients (Fig 2), the duration of surgery (Fig 3), and the site of operation (Fig 4) are usually considered in analyses of this kind. Among our patients very little difference was noted between the patients in the two halves of their eighth decade and the patients past eighty. The results are probably tainted by the fact that elective surgery is not too frequent in this age group. The duration of surgery had absolutely no effect on the outcome, perhaps because, as the patients' conditions become more desperate, the operations tend to be shorter. This is supported by the high mortality associated with anaesthetic times of less than one hour.

FIGURE 2 The age-distribution of our subjects. In this and in all the following figures except Fig 7, the ordinate is marked in percentage mortality while the numbers along the abscissa mark the cumulative total of patients. The area of each rectangle is proportional to each group's contribution to the total mortality.

FIGURE 3

FIGURE 4

Our population of intracranial and thoracic surgical patients is relatively small. The mortality rates in these groups might have been unduly influenced by the demise of a few patients who were moribund pre-operatively. We were particularly impressed by the ease with which many elderly patients tolerated long and bloody neurosurgical procedures. The large mortality associated with operations on the gastro-intestinal tract is due to the grave pre-operative state of many such patients and to the underlying malignant disease in many others.

There is of course nothing new in the statement that the preparation of patients for surgery will profoundly affect the outcome of the operation. Nevertheless, the extent of the effect might come as a surprise (Fig 5). We have classified as "emergency" those patients in whom the operation could not be safely postponed for more than six hours. They include cases of bleeding, perforation of a viscus, and advanced cases of intestinal obstruction. These patients were desperately sick when first seen and could not be ideally prepared for surgery. In the second or "urgent" group we included those patients whose disease permitted more time for pre-operative treatment, up to a maximum of six days.

FIGURE 5

This group included fractures, chronic, partial, or recent complete obstruction of the large bowel, progressive jaundice, brain tumors, and the implantation of cardiac pacemakers. Most of the patients received vigorous treatment directed to their blood volume, fluid balance, and cardiorespiratory status before surgery. In the "elective" group we were still left with some patients who had no real choice about undergoing surgery, such as patients with non-obstructive malignancies, peripheral vascular disease, symptomatic incisional hernias, or those requiring extensive reconstructive surgery. In spite of this, we have lost only two patients from this large group in two years.

From the standpoint of anaesthesia, it was, of course, most interesting to investigate the influence of various anaesthetic agents and techniques upon survival, especially because a new anaesthetic agent NLA (neuroleptanalgesic mixture) was introduced more widely in our hospital early in 1963. Our assessment of this drug combination has been presented elsewhere,¹²⁻¹⁴ and there have been an increasing number of communications relating to this technique from both sides of the Atlantic.¹⁵⁻¹⁷ This new method of supplementing nitrous oxide-relaxant anaesthesia appeared to us to be well suited for geriatric anaesthesia and for the management of other poor-risk patients. The raw data (Fig 6) were singularly unimpressive and tended to confirm a recent claim¹¹ that the choice of anaesthesia did not influence survival in geriatric surgery. Closer analysis, however, revealed an important fault in our reasoning: the presentation in Figure 6 implies that the choice of anaesthetics was not at all influenced by the patient's status, the contemplated surgery, and other similar considerations. If such influences were not taken into account, the comparison of several groups, each selected according to a different biased viewpoint, would be without meaning or interest. In our own series the assignment of an anaesthetic technique was definitely not at random. On the contrary, it appeared that most of our worst-risk patients received NLA. Our problem, then, was to find a statistical approach which could evaluate the success of a given treatment in the absence of any valid control group. The present solution is a crude one, applicable only when greater than 10 per cent mortality is to be expected in the absence of treatment and when the treatment is truly effective. By the same token a proof of statistical significance by such a method should carry added weight.

FIGURE 6

Since elderly sick people are notorious for their lack of uniformity, we could not expect to collect a representative series of matched cases. We have assumed instead that over a period of roughly two months the hospitalized patient population will average out well enough in terms of operations and surgical risk to make a comparison of one such period with another statistically valid. In other words, we randomized our data by dividing 300 operations into twelve consecutive groups of 25 operations each (the last 13 operations were disregarded) and we examined the number of deaths and the use of NLA in each of these groups (Fig 7, line 1). The negative correlation between mortality and the use of NLA (Fig 7, line 2) is striking and statistically probably significant ($p = 0.05$). It is gratifying, though of doubtful significance, that the intercept of our regression line corresponds closely with the mortality obtained from the literature.

FIGURE 7 The effect of neurolept-analgesia upon mortality. Line 1 Number of deaths and number of patients receiving NLA in consecutive groups of 25 operations each. The colour code divides these groups into 0-25%, 25-50% and 50% + NLA. Line 2 Correlation between mortality and the use of NLA in the combined groups. The average mortality gleaned from references 1-11 is included for comparison. The observed negative correlation is statistically significant ($p = 0.05$).

The data in Figure 7 indicate that the shift from other anaesthetics to NLA will account for about two-thirds of the improvement in the mortality rate. To this extent, then, at least two-thirds of the deaths observed with conventional anaesthetics in this population should be regarded as anaesthetic deaths. This is

surely not so within the normal definition of the term, that is to say, mortality following the exhibition of these agents is not due to some harmful effect of the drugs or to some error in the anaesthetist's management of the case.

It should be kept in mind that most anaesthetic drugs are chosen on the basis of their short action and that the ideal anaesthetic is thought to be one which would leave the patient in complete control of his homeostasis as soon as the dressing of his incision is completed. One might well argue, and it has indeed been pointed out in certain contexts, that while such management is probably ideal for reasonably fit patients, it will leave the patient with limited resources in a dangerous predicament. There are several factors that contribute to an increase of oxygen requirements and to a resulting increase in CO_2 production immediately after awakening from anaesthesia.

- 1 Most frail patients will be mildly or moderately hypothermic after prolonged surgery in air-conditioned operating rooms. This leads to shivering as soon as their thermo-regulation recovers and may increase the O_2 demand by as much as six times.

- 2 Pain and apprehension may by themselves double the O_2 demand. Following abdominal surgery the incisional pain imposes a rapid shallow breathing pattern which is inefficient and, therefore, further increases the patient's work-load.

- 3 If for any reason (cf. below) the arterial blood is not fully saturated, a compensatory increase in cardiac output is needed to provide the necessary O_2 to the periphery. Similar increases will be caused by haemodilution (a regular feature) and by increased viscosity of the blood, which increases myocardial work for a given cardiac output. The situation might be worsened by mild hypovolaemia and sluggish vasomotor reflexes, which are sometimes difficult to avoid in such patients.

The increased demand confronts patients when their O_2 uptake is curtailed because

- 1 Their lungs are virtually denitrogenated following general anaesthesia lasting longer than 60 minutes. Combined with the shallow breathing mentioned previously, this will produce disseminated alveolar collapse that may add up to significant shunting of blood across the lungs.

- 2 In many instances the situation will be aggravated by depressed ciliary action immediately after surgery. The mouth-breathing seen in most of these patients will promote the drying of secretion, thus further compromising the clearing of the lower airway.

It is noteworthy that most of the problems just outlined are of short duration. They last a few hours at the most. If the patient is left to his own resources to deal with them he will in most cases find the necessary reserves, even if he is in this poor-risk group. However, the completeness of his recovery and the cost in terms of cardiorespiratory and metabolic effort remain in doubt. There is a much smaller group of patients who reach the operating table with no cardiorespiratory reserves whatever; they cannot respond to the increased demands of recovery from anaesthesia and surgery. They will lapse into a vicious circle in which the cost of furnishing O_2 to their tissues and eliminating CO_2 is greater

than the energy-equivalent of the O_2 furnished by each breath, and they will die in complete exhaustion 6–48 hours after surgery. Our data can be taken to indicate the presence of yet a third group of patients who may be kept out of these vicious circles by timely and short-term assistance of their respirations. Such assistance will.

1 Furnish deep, slow breaths and thus re-establish the nitrogen scaffolding of the lungs

2 Reduce the O_2 requirements by almost completely eliminating the work of respiration

3 Keep the patients mildly sedated through hyperventilation and provide fully humidified air until the cilia resume their activity

Providing such assistance as a prophylactic measure and on the scale that we believe to be useful implies the retention of endotracheal tubes in our patients for at least a few hours after surgery. The only alternative to this would be tracheotomy, which is ruled out by the associated risks and nursing problems. In this respect, NLA proved to be extremely valuable. It can be fairly said that it presents a qualitative advantage over previously available anaesthetics. We have found that while only the exceptional patient tolerated an endotracheal tube for any length of time after conventional anaesthesia, the majority of elderly patients receiving NLA would comfortably tolerate prolonged respiratory assistance even when they were sufficiently awake to communicate with us by signs or by writing. The mortality for patients assisted after surgery is the same as for those who received no such assistance in this series (Fig 8). This result has been achieved, however, in face of a double bias favouring survival among the group which had no respiratory assistance, since most of the really sick patients found their way into the “respirator” group. We submit it for what it may be worth on the basis of our present data. Further work is now in progress to determine more exactly the O_2 cost of recovery from anaesthesia and surgery and the possible sparing action of limited respiratory assistance upon this parameter.

FIGURE 8

Needless to say, the situation in which a patient might benefit from respiratory assistance after surgery does not start with his first old-age pension cheque. We consider that today all patients undergoing major surgery of a body cavity may benefit by such treatment, and we are now prepared to furnish it for as long

as they are not disturbed by the endotracheal tubes. It should be pointed out that we consider NLA as the anaesthetic of choice in the management of special-risk patients, principally because it makes such assistance possible. It might very well be that in the hands of those who do not avail themselves of this advantage, the results obtained with NLA will be no different from those obtained with other anaesthetics. Our rule of thumb for the pre-operative appraisal of our patients' need for respiratory assistance after surgery is that those who cannot climb a flight of stairs at the time of pre-operative rounds should have respiratory assistance till the morning after surgery. During this period we do not hesitate to give them further sub-anaesthetic doses of NLA if they will not tolerate the endotracheal tube otherwise. By the nature of things, with increasing age an ever larger percentage of patients will fall into this group. Patients who are dyspnoeic at rest before surgery are considered to be serious candidates for prophylactic tracheotomy, since their need for respiratory assistance is likely to continue for several days.

The plea for post-anaesthetic respiratory assistance has been made before, but it was restricted to cardiac bypass procedures,¹⁸ open chest cases,¹⁹ or overwhelming peritoneal infection,²⁰ and all authors considered tracheotomy as a prerequisite. Our claim is that limited respiratory assistance is indicated much more often after surgery than has been suspected, and that it is a feasible procedure without tracheotomy when NLA is employed. Our nursing staff adapted easily to this new regime and we could satisfy all demands of an average daily operating list of 70 cases, as well as the other demands of a 1000-bed hospital with five respirators in the recovery room and in the intensive care unit. We estimate that as a result of these changes about one patient each month now leaves the hospital who as recently as two years ago would not have had the benefit of surgery or would not have survived the operation.

SUMMARY

We have reviewed the incidence of major surgery in geriatric patients in our hospital. There were 313 such operations performed in 1963 and 1964, with an over-all mortality of 13 per cent. Less than one per cent of all operations and only about 15 per cent of the geriatric surgery satisfied our criteria, yet these patients accounted for 10 per cent of our surgical and for 45 per cent of our geriatric surgical mortality.

Among the various factors investigated, the site of surgery and operating time were found not to contribute significantly to mortality. The age of our subjects had some effect, and the time available for pre-operative therapy had a marked effect.

Anaesthetic agents had no effect on mortality at first sight, but when the choice of different agents was taken into account a statistically significant negative correlation emerged between mortality and the use of neuroleptanalgesia. This observation is tentatively explained by the fact that NLA makes it possible to assist the respiration of most elderly patients for some time after surgery. The rationale for this treatment and our procedure are discussed in some detail.

RÉSUMÉ

Nous avons étudié les patients gériatriques qui ont subi des opérations majeures dans notre hôpital en 1963 et 1964. Sur 313 opérations, nous avons eu 13 pour cent de mortalité. Bien que ces opérations représentent moins de 1 pour cent de toutes les opérations et 15 pour cent seulement de la chirurgie gériatrique, le taux de mortalité de ce groupe contribue pour 10 pour cent des mortalités chirurgicales et pour 45 pour cent de la mortalité gériatrique.

Parmi les divers facteurs que nous avons investigués, nous avons trouvé que le taux de mortalité n'était pas relié au site opératoire ni à la durée de l'opération. Par contre l'âge du patient avait une certaine influence sur le taux de mortalité et la préparation du patient en préopératoire avait une influence des plus significatives.

Les anesthésiques employés ne semblent pas être un facteur d'importance à première vue, mais quand le choix de différents agents est pris en considération, on s'aperçoit qu'il y a une corrélation négative significative entre l'emploi de la neuroleptanalgesie (NLA) et le taux de mortalité. Cette amélioration nous paraît due au fait que le NLA nous avait permis de mieux assister la respiration en postopératoire d'un grand nombre de nos patients.

REFERENCES

- 1 KYRLE, P. Operative Results of Biliary Surgery in Patients over 65. *Arch klin Chir* 287 761 (1957)
- 2 WILKINS, L. F. & KNIGHT, C. D. Abdominal Surgery in the Aged. *A M A Arch Surg* 76 963 (1958)
- 3 NISSEN, R. Recent Advances in Geriatrics. *Arch klin Chir* 287 121 (1957)
- 4 DE PEYSTER, F. A. & GILCHRIST, R. K. Current Principles Governing Abdominal Surgery in the Aged. *A M A Arch Surg* 83 154 (1961)
- 5 HERRON, P. W., *et al*. Analysis of 600 Major Operations of Patients over 70 Years of Age. *Ann Surg* 152 686 (1961)
- 6 GEMAHLICH, M. & KRAUTWIG, K. TH. Experiences in Geriatric Surgery. *Z Alternsforsch* 15 106 (1961)
- 7 STAHLGREN, L. H. An Analysis of Factors Which Influence Mortality following Extensive Abdominal Operations upon Geriatric Patients. *Surg Gynec & Obst* 113 283 (1961)
- 8 ROBINS, R. E. & MIDDLETON, A. G. Major Abdominal Surgery in Patients over 70 Years of Age. An Analysis. *Canad J Surg* 7 129 (1964)
- 9 LORHAN, P. H., *et al*. Factors Influencing Mortality following Anaesthesia in Gallbladder Surgery. *Anesth Analg Curr Res* 43 708 (1964)
- 10 FRY, H. J. H. Mortality in Emergency Surgical Admissions over the Age of 70 Years. *Brit J Surg* 51 837 (1964)
- 11 MARSHALL, W. H. & FAHEY, P. J. Operative Complications and Mortality in Patients over 80 Years of Age. *A M A Arch Surg* 88 896 (1964)
- 12 KEÉRI-SZANTO, M., TELMOSSE, F., & TROP, D. Anaesthetic Time Dose Curves. V. Data on Neuroleptic Drugs with Remarks about their Action. *Canad Anaesth Soc J* 10 484 (1963)
- 13 CARIGNAN, C., *et al*. Innovar®. First Experiences with a new Intravenous Anaesthetic in a Teaching Hospital. *Anes Analg Curr Res* 43 550 (1964)
- 14 AUBRY, U., *et al*. Neuroleptanalgesia. Analysis of a Personal series of 1007 Cases. To be published
- 15 HOLDERNESS, M. C., CHASE, P. E., & DRIPPS, R. D. A Narcotic Analgesic and Butyrophemon with Nitrous Oxide for General Anaesthesia. *Anesthesiology* 24 336 (1964)
- 16 CORSSSEN, G., DOMINO, E. F., & SWEET, R. B. Neuroleptanalgesia and Anaesthesia. *Anes Analg Curr Res* 43 748 (1964)

17. NILSSON, E Origin and Rationale of Neuroplept-Analgesia Anesthesiology 24 267
 (1963)
18. DAMMANN, J F JR The Importance of Controlled Ventilation following Open-Heart
 Surgery. Internat Anaesth Clin 55 (1963)
19. NORLANDER, O P Etiology and Treatment of Respiratory Insufficiency Concept of
 Respiratory Work Minerva anesthesiol · cf. Surv Anaesthesiol 8: 178 (1964)
20. BURKE, J F, PONTOPPIDAN, H, & WELCH, C E High-Output Respiratory Failure
 An Important Cause of Death Ascribed to Peritonitis or Ileus Ann. Surg 158 581
 (1963)