

PERIOPERATIVE MORBIDITY AND MORTALITY ASSOCIATED WITH VITREO-RETINAL AND OCULAR ONCOLOGIC SURGERY PERFORMED UNDER GENERAL ANESTHESIA

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ABSTRACT

Purpose: To determine the incidence of postoperative systemic complications and nonophthalmic reasons for prolonged hospitalization after vitreoretinal procedures performed under general anesthesia.

Methods: Patient charts of vitreoretinal or ocular oncologic surgical cases performed under general anesthesia between 1996 and 2001 were reviewed retrospectively. Occurrences of postoperative systemic events within 4 weeks of surgery were documented.

Results: We identified 418 cases as having been performed under general anesthesia during the study period. The mean American Society of Anesthesiology physical status classification was 2.1. There were no confirmed cases of myocardial infarction (MI), pulmonary embolism (PE), or deep venous thrombosis (DVT) within the first 24 hours after surgery. There were two instances of hospital admission for evaluation of postoperative chest pain (0.48%; 95% CI, 0.06-1.72), and four instances of hospital admission, or prolongation of stay, because of urinary retention (0.96%; 95% CI, 0.26-2.43). In the 4 weeks following surgery, there was one MI (0.24%; 95% CI, 0.01-1.33), 2 cases of nonfatal PE (0.48%; 95% CI, 0.06-1.72), and 2 cases of DVT (0.48%; 95% CI, 0.06-1.72). All patients that developed PE and DVT had risk factors for the development of thromboembolic disease in addition to surgery under general anesthesia.

Conclusions: In this study, 2.6% of cases had postoperative systemic complications after vitreoretinal or ocular oncologic surgery that was conducted under general anesthesia. Urinary retention was the most common reason for unanticipated hospital stay.

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INTRODUCTION

Postoperative systemic complications related to surgery utilizing general anesthesia are well known. These complications include pulmonary embolism (PE), deep venous thrombosis (DVT) without PE, myocardial infarction (MI), stroke, pneumonia (aspiration and nonaspiration), and urinary retention. A voluminous body of literature details risk factors for developing postoperative complications among patients undergoing non-eye-related surgery,^{1,2} but there is little information regarding the risk of developing serious systemic postoperative complications following eye surgery. Studies addressing death rates after ocular surgery from 19 or more years ago

indicate a low mortality rate. In 1974, Quigly³ reported a 0.1% "adjusted" death rate. In 1973, Breslin⁴ summarized five studies and reported a death rate of 0.06%. However, there is little information documenting the incidence of systemic morbidities after eye surgery performed under general anesthesia, and specifically after vitreoretinal surgery performed under general anesthesia.

Warner and colleagues⁵ reported in 1993 that after ambulatory surgery, involving either general or local anesthesia techniques, the complication rate was extremely low. Among 45,090 procedures, there were 14 MIs and five PEs within 30 days of surgery. Four deaths occurred in the study period, but two were attributed to automobile accidents and were not considered postoperative complications. The investigators did not report the length of surgery or subdivide the complications according to surgical specialties or types. One study⁶ specifically addressed the occurrence of systemic intraoperative and postoperative (within 1 week of surgery) complications following eye surgery. That study was composed of patients undergoing cataract surgery with local anesthesia with or with-

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Bold type indicates AOS member.

out intravenous sedation. The investigators catalogued many types of events; they observed that the rate of MI among the 19,250 patients was 0.0004%; there were no recognized thromboembolic events.

The goal of the present study is to quantify the incidence of systemic postoperative complications after vitreoretinal and ocular oncologic surgery performed under general anesthesia.

METHODS

This study represents a retrospective noninterventional case series. Adult patients (>17 years of age) undergoing vitreoretinal or ocular oncologic surgical procedures conducted with general anesthesia between 1997 and 2001 were identified. All cases of enucleation performed by the vitreoretinal service (three surgeons), even if not performed for an oncologic diagnosis, were included as "ocular oncologic procedures." The patients' medical records were reviewed for documentation of systemic postoperative complications. Patient age, sex, preoperative American Society of Anesthesiology (ASA) physical status classification system,¹ operative time and procedure, and type and date of complication were recorded. Postoperative systemic incidents were categorized as "immediate," occurring within 24 hours, or "perioperative," occurring within 30 days.

Statistical analysis was conducted using unpaired *t* tests and chi-square analyses.

The study was approved by the institutional review board of the Mayo Clinic.

RESULTS

In the study period, 418 cases of vitreoretinal or ocular oncologic surgical procedures performed under general anesthesia were identified. There were 363 patients, 42 (11.6%) of whom had multiple procedures during the study period. More than half (51.2%) of the patients were men, and 57.9% of the surgeries were performed on men. Considering all 418 cases, the mean patient age at the time of each procedure was 55.6 years, the mean ASA score was 2.1, and the mean operative time was 130 minutes. Among cases, there were six immediate postoperative events and five perioperative events. The six immediate postoperative events included four cases of urinary retention requiring hospital admission or prolongation of hospital stay (0.96%; 95% CI, 0.26-2.43) and two cases of chest pain requiring admission to rule out MI (0.48%; 95% CI, 0.06-1.72). Perioperative events included one nonfatal MI (0.24%; 95% CI, 0.01-1.33), two cases of nonfatal PE (0.48%; 95% CI, 0.06-1.72), and two cases of DVT without PE (0.48%; 95% CI, 0.06-1.72).

Additionally, one patient developed a DVT that was diagnosed outside of the defined perioperative period; however, we believe this event was likely related to the surgical procedures that the patient had undergone. One patient died 2 weeks following brachytherapy in which a radioactive episcleral plaque was placed over the choroidal melanoma. This patient was excluded from our analysis because the death occurred immediately following major abdominal (bowel) surgery conducted 2 weeks after the brachytherapy.

Table I lists the recognized complications during the predefined perioperative period. Table II provides further details of each case, including risk factors for the complication that were in addition to the risk incurred by the general anesthesia. Table III groups the cases into those undergoing vitreoretinal surgery (scleral buckle, scleral buckle revision, or vitrectomy) and those having ocular oncology-related procedures (enucleation or brachytherapy plaque placement).

DISCUSSION

There is little available data to estimate the risk of systemic complications after general anesthesia for ocular procedures. This study is based on a chart review of all cases performed by three vitreoretinal and ocular oncologic surgeons in a single department over a 5-year period. While the number of cases is limited, the results of this study are instructive.

The incidence of serious systemic complications (MI, PE, and DVT) was 1.2%. While the event rate may seem high, it must be viewed in the context that we included adverse events up to 4 weeks postoperatively; in contrast, most other studies have defined the postoperative period

TABLE I: SUMMARY OF POSTOPERATIVE EVENTS AND INCIDENCE IN 418 PATIENTS

COMPLICATION	NO.	INCIDENCE (95% CI)
Chest pain (requiring overnight evaluation)	2	0.48% (0.06-1.72)
Urinary retention requiring admission or prolongation of hospitalization	4	0.96% (0.26-2.43)
Myocardial infarction	1	0.24% (0.01-1.33)
Pulmonary embolism (nonfatal)	2	0.48% (0.06-1.72)
Deep venous thrombosis	2	0.48% (0.06-1.72)

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TABLE II: CASE SPECIFICS OF POSTOPERATIVE COMPLICATIONS

CASE	ASA	PROCEDURE	OPERATIVE TIME	COMPLICATION DETAILS	ADDITIONAL RISK FACTOR FOR COMPLICATION
MI	3	SB revision	1:35	Inferior MI diagnosed 22 days after eye surgery	Postoperatively, severe nausea, vomiting, and dehydration for 6 days including 2-day hospital stay for rehydration; 2 weeks later, diagnosed with MI
PE 1	2	PVR RD repair with silicone oil	5:10	Sudden-onset shortness of breath 18 days after surgery	6-hr drive to Mayo Clinic
PE 2	3	Submacular hemorrhage extraction with gas bubble and positioning	2:09	New-onset shortness of breath and atrial fibrillation 13 days after eye surgery	Preoperatively, Coumadin therapy was discontinued; history of DVT
DVT 1	2	SB revision	1:46	Swollen lower extremity diagnosed as DVT 27 days after eye surgery	Possible protein S deficiency
DVT 2	2	PPV/SB revision with gas bubble and positioning	2:45	DVT diagnosed 2 wk after surgery	Preoperative leg injury and 7-hr drive to Mayo Clinic

ASA, American Society of Anesthesiology physical status classification system; DVT, deep venous thrombosis; MI, myocardial infarction; PE, pulmonary embolism; PPV, pars plana vitrectomy; PVR, proliferative vitreoretinopathy; RD, retinal detachment; SB, scleral buckle.

TABLE III: CASES GROUPED BY SURGERY TYPE (VITREORETINAL OR OCULAR ONCOLOGY)

SURGERY TYPE (N = 418)	MEAN PROCEDURE AGE (YR) (P = .01)	MEAN OPERATION TIME ± SD (MIN) ^o (P<.0001)	MEAN ASA SCORE (P=.31)	NO. OF EVENTS WITHIN 24 HR	NO. OF EVENTS BETWEEN 24 HR AND 28 DAYS AFTER SURGERY
Vitreoretinal† (n=284)	53.9 ± 17.9	152.7 ± 70.9	2.1	6	5
Oncology related‡ (n=134)	58.7 ± 15.7	82.8 ± 39.9	2.2	0	0

ASA, American Society of Anesthesiology physical status classification system.

^oIn six cases the operative time was not recorded.

†Scleral buckle, scleral buckle revision, and vitrectomy.

‡Brachytherapy plaque placement and enucleation (includes enucleations other than eye tumor-related, if performed on the vitreoretinal service).

as 1 week. If we had defined the postoperative period as 1 week for this study, there would have been no serious systemic events; there were no serious events in our study before 2 weeks (Table II). Nevertheless, after review of each adverse event case, it seems likely that the surgery contributed to or caused the complication that developed. Thus it seems justified to include the complications that occurred up to 1 month after surgery. A precedent for using the 4-week perioperative period for assessment has been published by others in a report of the rate of complications after ambulatory surgery.⁵

In our study, we reviewed patients undergoing vitreoretinal or ocular oncologic surgery with general anesthesia. Noteworthy is that all of the observed systemic events

in our study occurred among patients undergoing vitreoretinal surgery. There were no perioperative events among the patients undergoing ocular oncologic surgery. The all-events rate among ocular oncologic procedures was 0 of 134 (0%), compared with 11 of 284 (3.9%) among vitreoretinal procedures. This difference is statistically significant (P=.02). When only DVT, PE, and MI are considered (5 of 284 [1.8%] among vitreoretinal procedures), the difference is not statistically significant (P=.13). The differences in these observed systemic event rates may be explained by factors other than the type of surgery; the ocular oncologic cases involved statistically younger patients and statistically shorter operating times (Table I).

Among patients experiencing serious postoperative events in our study, each had predisposing risk factors or events in addition to the surgery and the general anesthesia itself that predisposed them to the complication (Table II). The duration of surgery was greater than 90 minutes in all four cases (0.96%) with thromboembolic complications, suggesting that the longer duration of surgery is a significant risk factor. Additionally, vitreoretinal procedures often require postoperative positioning that leaves the patient relatively immobile, possibly increasing the risk of thromboembolic disease. One patient had long travel time to Rochester (6 hours), one had postoperative face-down positioning associated with gas tamponade, and one patient had both long travel time (7 hours) and face-down positioning. Thus, three of the four patients with thromboembolic complications had prolonged immobility, a known risk factor for DVT and PE. The risk factor is so well established that with regard to air travel it has been referred to as “economy class syndrome.”⁷ The fourth patient with a thromboembolic complication, a DVT, was diagnosed as having possible protein S deficiency and also had had a leg injury with soft-tissue trauma. All of these factors have been cited by others as important risk factors for the development of systemic complications. For example, the Federated Ambulatory Surgery Association reported that longer operative times were associated with an increased risk of systemic postoperative complications.¹⁵ The report concluded that operative times of greater than 1 hour increase the risk significantly.

A study conducted at the University of Iowa evaluated the rate of postoperative DVT and PE among 12,805 otolaryngology–head and neck surgical patients over a 7-year period.⁹ The overall rate of thromboembolic disease was 0.27%: isolated DVT occurred in 0.1% (10 patients) and PE in 0.2% (24 patients); two of the 24 patients with PE died as a result of the event (0.02%). A risk factor identified in the Iowa study was age greater than 70 years. It was also noted that the operative time was greater than 2 hours in “most” instances when patients developed PE or DVT. The incidence numbers were higher than the investigators expected. They observed that the rate of complications varied among the otolaryngology subspecialties. The rate of thromboembolic disease in head and neck surgery was 1.0%, otology/neurotology 0.5%, head and neck trauma and plastic surgery 0.2%, and general otolaryngology 0.14%.

In our study, the single case of nonfatal MI was not likely precipitated by the surgery itself, but the severe postoperative nausea and vomiting, lasting 6 days, and subsequent dehydration may have led to the infarction, which occurred some time between surgery and diagnosis 22 days after surgery. Nonetheless, the scleral buckle revision may have led to the nausea and vomiting, and

therefore a causal relationship seems likely. In a previous study evaluating the rate of MI in a high-risk group of patients who had had a previous MI and subsequently underwent eye surgery, Backer and colleagues¹⁰ did not find any instances of reinfarction. In that study, there were 26 procedures in 21 patients performed under general anesthesia and 288 procedures performed under local anesthesia. It was concluded that eye surgery performed under local anesthesia is a low cardiac risk procedure; a conclusion regarding the risk of general anesthesia could not be made because patient numbers were too low.

Among the immediate postoperative events, the two admissions for chest pain evaluation are not surprising given the widespread age of the patient population, which included individuals of advanced age. The two cases of postoperative chest pain that were diagnosed as angina occurred in patients who were 83 and 64 years of age. The 83-year-old patient had a known history of coronary artery disease. Each of the surgeries was long (175 minutes for the 83-year-old and 260 minutes for the 64-year-old), which probably contributed to the development of angina.

During the immediate postoperative period, we observed six cases (1.4%) of urinary retention that required catheterization, hospital admission, or hospital stay prolongation. Four of these instances led to hospital admission or prolongation for management of the urinary retention (0.96%). Urinary retention is known to occur after general anesthesia at rates reported from 7% to 52% of patients.¹¹⁻¹³ The definition of urinary retention differs among studies, which is likely responsible for the very differing rates reported. Most series evaluating the rate of urinary retention are from the general surgery or anesthesia literature and conclude that urinary retention is more common in men and the elderly.^{11,12} Among our 6 patients with urinary retention in the present study, 4 were men (mean age, 70 years). Stricker and colleagues¹¹ compared the rates of urinary retention among surgical subspecialties, including ophthalmology, and did not find significantly differing rates. While they found an overall rate of urinary retention of 20%, only 8 (2.2%) of their patients required catheterization, which is not statistically different from the rate of serious urinary retention found in this study (1.7%, $P=.44$). While urinary retention is not usually a life-threatening complication, increases in cost of care and difficulty of urinary retention management in the ambulatory setting may be encountered and should be considered.

In summary, the rates of DVT, PE, and MI were higher than anticipated in this study of patients undergoing vitreoretinal and ocular oncologic procedures under general anesthesia. Additionally, a significant number of

patients had to be admitted to the hospital for either chest pain evaluation or urinary retention management. Long operative times (>90 minutes), advanced age, and non-surgery-related risk factors were prominent among patients who developed complications and place such patients in moderate to high risk for thromboembolic disease.¹⁴ Surgeons should be aware of this data in their operative planning and consider thromboembolic disease prophylactic measures for surgical cases performed under general anesthesia anticipated to last more than 90 minutes and for patients that may have risk factors for thromboembolic disease other than the surgical procedure under general anesthesia itself. Recommended prophylactic measures to minimize the risk of thromboembolic disease in patients at moderate to high risk include sequential compression stockings (intermittent pneumatic compression) and either low-dose unfractionated heparin or low-molecular-weight heparin.¹⁴

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DISCUSSION

DR DAVID J. WILSON. Dr McCannel and coworkers' paper provides very useful information regarding the risk of serious postoperative systemic complications in patients undergoing vitreoretinal and ocular oncology procedures under general anesthesia. The authors defined serious postoperative complications as myocardial infarction, pulmonary embolism, and deep vein thrombosis.

The authors found that there was an overall incidence of these complications in 1.2% of patients in their study. This incidence was characterized as higher than expected, and was significantly higher than rates found in other studies of ambulatory eye surgery or ENT surgery. Reasons for this higher rate could be several, and include: 1) age of the patient population, 2) duration of the procedure, 3) postoperative positioning, 4) lack of preventive measures to reduce the risk of pulmonary emboli and deep vein thrombosis, 5) methodological differences between the different studies. Of these I am most inclined to attribute a real difference to postoperative positioning. As the authors point out, vitreoretinal procedures are often followed by a period of postoperative positioning that could increase the risk of deep vein thrombosis and pulmonary embolus. This type of positioning would not have been practiced by patients included in the other studies to which the authors compare their results. Also, other studies may not have used a perioperative period of 1 month, and shorter perioperative periods would spuriously lower the incidence of postoperative complications.

The authors should clarify the inclusion and exclusion criteria for patients in their study. During this period of time, did other patients undergo the same procedures under local anesthesia? If so, what were the criteria for choosing local or general anesthesia? If patients at higher risk for general anesthesia underwent surgery under local anesthesia, it would be safe to assume that the risk for serious complication for all patients under general anesthesia would be significantly higher. If a substantial number of patients underwent the same procedures under local anesthesia, it would be interesting to compare the incidence of severe complications in the two groups as this might give some indication on whether the complications were related to the general anesthetic or the postoperative positioning. One other minor point is that the

authors should state if they reviewed the patient's entire medical record, or just what was recorded in the patient's eye clinic chart.

In summary, the authors are to be congratulated for performing a study that raises our awareness of the low, but very real risk of serious systemic complications following general anesthesia in vitreoretinal surgery. Hopefully, this increased awareness and the measures they suggest can lower the incidence of these complications.

DR JOHN F. O'NEILL. Working primarily with children, were we do mostly strabismus surgery and almost always under general anesthesia, parents are asking about the risks of anesthesia. A few years back, I would use our anesthesiologist's figures and indicate that 1 in 10,000 was approximately the incidence of having a serious event following anesthesia. The current figures from our anesthesiologists are 1 in 250,000 from the Anesthesia Society data. What do you tell your parents that guide them when you're going to utilize general anesthesia?

DR CHARLES P. WILKINSON. We recently had a death at Wilmer in an adult strabismus patient that requested general anesthesia. He had been on Coumadin and had the Coumadin stopped. There was also a question of another platelet affecting drug that the patient may have been taking. We really don't want to see bleeding post-op and you wonder about heparin, particularly in our diabetic patients. How does the Mayo Group specifically manage such patients in whom you want to discontinue blood thinners for surgery?

DR JAMES C. BOBROW. We are now being faced with a barrage from insurance companies regarding whether or not monitored anesthesia is necessary for various types of ocular surgery. On your list of reasons for general anesthesia, you list, "patient request." I think that we all should be somewhat resistant to the idea of patient requests. Certainly with the techniques of monitored anesthesia that have been employed in the last 5-10 years with short acting anesthetic agents, it has been possible to make patients quite comfortable even for longer procedures with other methods than general anesthesia. In addition in patients undergoing local anesthesia, the same positioning problems and the same kinds of postoperative care occur. I wonder if a group of patients operated on in a similar interval could be used as a control group to look at whether or not positioning alone is the concern or whether these complications are related to the general anesthesia itself?

DR HUGH R. TAYLOR. One conclusion you could draw from this study is to ask the question, whether one should

do the surgery or not do the surgery? The more useful question is, if you are going to do vitreous surgery on a patient, whether it should be done under general anesthetic or it should be done under local anesthetic? What you are really interested in is the additional risk of the general anesthetic compared to local anesthetic. It would be very interesting to look at patients, maybe matched for duration of surgery, to determine that incremental change in risk between local and general anesthetic.

It would also be particularly interesting to compare with the work that Dr Oliver Schein and his colleagues at the Wilmer reported a couple of years ago on the affect of interventional anesthesia on cataract surgery. They showed a linear increase in the risk of complications with the number of intravenous drugs that were administered. Their lowest risk of complications were purely topical anesthesia and once the anesthesiologist decided to give 3 or 4 different types of drugs intravenously, the rates of complications went up quite dramatically. Have you had the chance to compare your frequency of complications with general anesthesia in vitrectomy patients versus patients following cataract surgery?

DR DOUGLAS D. KOCH. The real power of your study is the fact that you followed these patients for 30 days. One potential factor in these patients is the psychological aftermath of the surgery. Was there postoperative depression or grief following these procedures that could have predisposed them to these complications, particularly myocardial infarction?

DR IVAN R. SCHWAB. This should not necessarily be the condemnation of general anesthesia, but rather the concern about the length of time of their transportation after surgery and the length of time of their surgery. The association may be real because of the length of time and the surgery and not necessarily general anesthesia. If you were to look at general anesthesia compared to local anesthesia you might find more local complications in those patients that received local. In other words, it may be safer for the patient's eye if you do general. I wouldn't necessarily condemn general anesthesia out of hand simply because we see the complications here. It may be the selection group. So the point about comparing it to local anesthesia, length of time, and other factors at least some of the problems stems from the length the time the patient sits in the car and associated disease problems. It may not be general anesthesia at all and, by condemning it, we lose the ability to save the local problems we see from local anesthesia, that is, eye problems.

DR THOMAS D. FRANCE. In the past year we had a death within 6 hours following a retinal vitrectomy. This was due

to a pulmonary embolism in a patient that was diabetic but had no other significant risk factors. Your recommendations would indicate that we should be thinking about the use of stockings or compressive stockings. I'm curious as to how many people in this room routinely do that sort of thing now or have been doing it or their anesthesiologist has been doing it. We could find nothing in the literature that this was a common practice.

DR COLIN A. MCCANNELL. With regard to the postoperative positioning, I didn't present some of the data that we have with regard to the positioning, at least among the patients that did have complications. It did not seem to be as big of an additional risk factor as the co-authors and I had thought it might be. It was really these other confounding factors, as I like to call them, which seemed to predispose the patients to the problems they had.

And why do we use general anesthesia? All three of us in our practice really dislike using general anesthesia. Some of our concern is about the higher risk for complications but it also relates to turnover time, longer operating time. There's a very high incentive for us as surgeons to have patients not undergo general anesthesia. Both the health risk factors and the overall surgical day management are important factors in that and I think we talk more patients out of it than let them talk us into it. There are the occasional patients that have anxiety disorders such as claustrophobia for whom it really is difficult to do under local anesthesia. Because there's a high rate of turnover of anesthesiologists or CRNAs, you can't rely on a very deep local or a monitored anesthesia to be occurring for a patient that has a very high level of anxiety. Those are the reasons we choose general anesthesia, in addition to when it's a patient request. Additionally we recommend the procedures in enucleation or brachytherapy placement since these can be difficult, painful, or emotionally difficult for the patient.

Yes, the entire medical record was looked at. We have the luxury at the Mayo Clinic that we get the whole record and we can look at everything that was ever collected by Mayo Clinic. We did review the entire medical record on these patients. Many patients were from out of town and there wasn't a whole lot of medical record present at Mayo: there we did the best without contacting the patient or the local physicians. We relied just from the eye notes to indicate if they had any problems since their last postoperative visit. What do we tell patients about risks of general anesthesia? I say that it's a significantly higher risk than monitored anesthesia care but it's hard to quantitate exactly. My approach to the risk discussion is to tell high-risk patients that it is a poor choice for them to undergo general anesthesia. When it comes to the more routine general anesthesia cases such as enucleations, I just tell

them there's a slightly higher risk. So it's very different depending on if I think it's a good idea to have general anesthesia or if the patient thinks it's a good idea to have general anesthesia in terms of how the counseling goes.

Regarding the management of Coumadin, I usually don't take the patients off of Coumadin any more. I found that even in diabetic surgery cases, the surgery isn't really much more difficult when the patient is coumadinized. I do take patients off when performing radial optic neurectomies because I'm concerned about those procedures. We communicate with the primary physician and ask them if we should put the patient in the hospital on heparin or should we just stop it based on the risk assessment for this patient. I prefer to be guided by the primary physician since they know much what the risks are for specific patient. Patients with artificial valves are usually admitted for heparinization, whereas patients who have had a 9-month ago history of a deep vein thrombosis will probably just be discontinued.

We did not look at the positioning specifically in our study in all patients, but, of the patients that did have complications, only two had positioning requirements after their surgery for more than overnight. The incremental risk of general vs. local anesthesia Dr Taylor suggests has not been evaluated. The data by Schein et al with the cataract surgery comp only addresses surgeries that are short, like cataract surgery, where there's a lot less stress for the patient. A lot of patients that have vitreoretinal surgery feel that there is more stress than when they had prior cataract surgery. How much do grief and emotional factors such as stress relate to complications? I don't know how to quantitate that. Patients that have more emotional problems tend to be a little sicker or more likely to get sick. That's something outside of the scope of this paper. Dr France asked what do we do for preoperative or perioperative management of risk. The sequential compression stockings are probably the best compromise between risk reduction and not introducing the potential of increased bleeding, such as subcutaneous heparin. Ped stockings alone are probably not satisfactory. Ped stockings plus sequential compression devices are recommended. They must be applied to the patient and turned on before the patient is put to sleep because venous stasis occurs as soon as the patient gets the muscle relaxers. It has been mentioned to me by anesthesiologists that if you apply them after the patient is asleep you reduce the prophylactic effect dramatically. We have a routine protocol in place to get these applied, although an occasional patient does not get them. At least 2 institutions that I have been associated with (Mayo Clinic and UCLA) use those routinely.