Pharmacoeconomics of intravenous regional anaesthesia *vs* general anaesthesia for outpatient hand surgery

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Purpose: To compare the cost and effectiveness of intravenous regional anaesthesia (IVRA) with general anaesthesia (GA) for outpatient hand surgery.

Method: A retrospective record analysis of 121 patients who received IVRA were compared with 64 patients who received GA in our Daycare centre. The costs of anaesthesia and recovery were calculated from an institutional perspective using 1995 Canadian Dollar values. Effectiveness was measured in terms of time for anaesthesia, recovery and discharge, % with unsatisfactory anaesthesia and complications.

Results: Both groups were well matched in terms of weight, sex and ASA class. Patients in the IVRA group were older (45 ± 16 vs 38 ± 13 yr) and had a lower frequency of two types of operation. The median total cost for the IVRA group of \$24.60 (15.76–55.29) was less than that for the GA group of \$48.66 (35.59–73.11), ($P < 0.00001$). Anaesthesia was unsatisfactory in 11% of the IVRA group, but in none having GA, ($P < 0.01$). Recovery was faster in the IVRA group with a median time to discharge of 70 (35–180) min compared with 118 (45–320) min in the GA group, ($P < 0.00001$). Vomiting requiring treatment occurred in 5% of the GA group, but in none having IVRA, ($P < 0.05$). Dizziness which delayed discharge also occurred in 5% of the GA group, but in none having IVRA, ($P < 0.05$).

Conclusion: The cost of anaesthesia and recovery using IVRA for outpatient hand surgery was half that of GA. Intravenous regional anaesthesia was less effective than GA in achieving satisfactory anaesthesia, equally effective in time to administer anaesthesia, and more effective in speeding recovery and minimising postoperative complications.

Objectif : Comparer le coût et l'efficacité de l'anesthésie régionale intraveineuse (ARIV) avec ceux de l'anesthésie générale (AG) en chirurgie ambulatoire de la main.

Méthodes : Cette étude rétrospective comparait les dossiers de 121 patients opérés sous ARIV avec ceux de 64 patients opérés sous AG dans notre centre de jour. Les coûts encourus pour l'anesthésie et la récupération étaient calculés en dollars canadiens de 1995 dans une perspective institutionnelle. Le temps requis pour l'anesthésie, la récupération et le congé, le pourcentage d'anesthésies non satisfaisantes et de complications ont servi comme critères d'efficacité.

Résultats : Les deux groupes étaient comparables pour le poids, le sexe et la classe ASA. Les patients du groupe ARIV étaient plus âgés (54 ± 16 vs 38 ± 13 ans) et avaient moins souvent subi deux types d'interventions. Le coût total médian pour le groupe ARIV se situait à 24,60\$ (15,60–55,29) comparativement à 48,66\$ (35,59 ± 73,11) pour le groupe AG, ($P < 0,00001$). L'anesthésie a été insatisfaisante pour 11% du groupe ARIV, mais pour aucun du groupe AG, ($P < 0,01$). Le groupe ARIV a récupéré plus rapidement avec un séjour médian en salle de réveil de 70 (35–180) min comparativement à 118 (45–320) min pour le groupe AG ($P < 0,00001$). Des vomissements nécessitant traitement sont survenus chez 5% du groupe AG, mais chez aucun du groupe ARIV ($P < 0,05$). Cinq pour cent des patients du groupe AG ont présenté des étourdissements suffisamment graves pour différer le congé comparativement à aucun du groupe ARIV ($P < 0,05$).

Conclusion : Pour la chirurgie ambulatoire de la main, l'anesthésie et la récupération coûtent deux fois moins cher avec l'ARIV qu'avec l'AG. L'anesthésie régionale intraveineuse est moins efficace sur le plan de la satisfaction, également efficace sur le plan de la durée requise pour l'administration de l'anesthésie et plus efficace sur le plan de la rapidité de la récupération et de l'incidence des complications.

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Accepted for publication August 2, 1997.

TO make rational choices in the present medical environment with its financial challenges, anaesthetists need to consider the cost as well as the benefits of alternative anaesthetic techniques.¹⁻² Regional anaesthesia for outpatient surgery appears to offer many advantages over general anaesthesia but valid comparisons of regional *vs* general anaesthesia (GA) for ambulatory surgery are not readily available and many of the advantages of regional anaesthesia are implied rather than substantiated.³ Intravenous regional anaesthesia (IVRA) is a practical form of anaesthesia for outpatient procedures, requiring inexpensive equipment, little preparation, minimal technical skills and an onset time of approximately ten minutes.³ Reduced recovery time and, hence, a reduction in the cost of recovery have been shown using axillary brachial plexus block⁴ but there is no information on the cost effectiveness of IVRA over GA.

The purpose of this study was to compare the direct hospital costs of anaesthesia for outpatient hand surgery with IVRA with those using GA. Effectiveness was evaluated as the time taken to administer anaesthesia, success of anaesthesia, time for recovery and anaesthetic complications.

Method

Anaesthesia for outpatient hand surgery at our institution is with either IVRA or GA: the choice depending on surgeon and patient preferences. After obtaining approval from the Clinical Screening Committee for Research Involving Human Subjects the records of all (337) patients who had outpatient hand or wrist surgery performed by two specialist hand surgeons during 1994 were selected. Patient records that were excluded from analysis (Table I) were: operations that were only ever performed with general anaesthesia (wrist arthroscopy, bilateral surgery, and surgery lasting > 90 min), operations that were usually performed with IVRA (carpal tunnel release), and those performed using other types of regional anaesthesia (brachial plexus block or local infiltration). One hundred and eighty-five charts were ultimately selected. A retrospective comparison between the 121 patients who had IVRA and the 64 who had GA was then carried out.

Costs of anaesthesia and recovery for each group were calculated in Canadian dollars at 1995 values. All values refer to the direct expense to the hospital and not to what the patient is charged. The study perspective was strictly institutional. Costs were assumed to be constant during the period of study. Physician reimbursement was not included in the analysis. Indirect costs such as lost wages, caretaker costs, travel costs and the cost of managing complications after

TABLE I Patient records

	<i>number</i>
All hand and wrist surgery 1994	337
<i>Exclusions</i>	
general anaesthesia only	27
carpal tunnel release	106
other type of anaesthetic	10
unavailable record	9
total analysed	185

discharge from hospital were not analysed. "Supplies" included all disposables used in the administration of anaesthesia and recovery care and included items such as cannulae, oxygen masks, intravenous tubing and fluids. It was assumed that one syringe and needle of the appropriate size was used for each drug administered. Sterilising costs of airway and breathing equipment labour and packaging were calculated by the Sterile Supply Department.

Drug costing was performed with the assumption that residual drug left in single use ampoules was wasted. "Gases" includes the cost of isoflurane calculated using the formula published by Dion.⁵ Oxygen and nitrous oxide costs were calculated using the cost per litre of bulk supply to the hospital. Fresh gas flows were not recorded on 30% of charts so the mean flow used in the other patients under study was substituted in order to estimate costs. Oxygen was given on a need only basis in the Post Anaesthetic Care Unit (PACU) and flow rates and durations were not usually recorded, so these costs could not be calculated.

The average cost of providing one hour of a registered nurse's time in our Day Care in 1995 was \$31.21. This figure takes into account leave and benefit entitlements. The average nurse to patient ratio, and the time a patient spent in the recovery room were used to calculate the nursing cost of recovery. Capital equipment depreciation was not included as monitors, anaesthetic machine and tourniquets were available for all cases regardless of anaesthesia type. The additional cost of the anaesthesia machine and various airway supplies for emergency use (which could be discarded ultimately) was not determined because this was also common for both techniques. During the study period, anaesthesia staff members were the same, nursing protocols and criteria for discharge from the recovery room (i.e., 30 min minimum stay, stable vital signs, no surgical bleeding, satisfactory analgesia and minimal side-effects) remained unchanged.

The following data were obtained from the patient charts: age, weight, sex, ASA class, duration of surgery,

type of surgery, drugs and supplies used in the operating room and recovery room, time from induction to incision, time spent in the recovery room, time to discharge, percent of patients with unsatisfactory anaesthesia, and complications. Assessment of satisfactory anaesthesia in the IVRA group was determined from the records by noting whether local infiltration was used to supplement the block or if conversion to general anaesthesia was required. When patients in the IVRA group were converted to GA because of unsatisfactory anaesthesia, they were analysed in the IVRA group and the additional cost of GA was added to their profile. Reusable items such as laryngeal mask airways were amortised over one year and assumed, according to manufacturers recommendation to be suitable for ten uses.

Statistical analysis was performed with the Number Cruncher computer program, version 5.03. Most of the continuous data were not normally distributed as determined by the Martinez-Inglewicz, Kolmogorov-Smirnov, and D'Agostino-Pearson Omnibus K^2 normality tests. These data are summarised as medians and ranges, and between group differences were analysed with Mann-Whitney tests. Age, weight, and operating time were normally distributed and were analysed by unpaired Student *t* tests. Categorical data were analysed using chi-square or Fisher's exact tests as appropriate. $P < 0.05$ was considered significant.

Results

The standard drug used in the 121 patients who had IVRA was lidocaine 0.5%; chloroprocaine 0.5% was used in 23%. Seventy-eight percent received intra-operative sedation, principally with a combination of midazolam and fentanyl. Propofol, alfentanil and sufentanil were used to sedate some patients. The standard technique used in the 64 patients who

received general anaesthesia was induction with propofol and opioid, insertion of laryngeal mask airway, and maintenance with oxygen, nitrous oxide and isoflurane. The exceptions to this were 13% who had endotracheal tubes inserted and 6% who had maintenance of anaesthesia with propofol infusions.

The two groups were matched except for the older age of the IVRA group and the higher frequency of two operations (reduction and/or fixation of fracture and excision of lesion wrist joint) in the general anaesthesia group (Table II). Except for the cost of anaesthetic supplies, all the costs of anaesthesia and recovery were higher in the general anaesthesia group (Table III).

TABLE II Demographic data

	IVRA	General anaesthesia	P
n	121	64	
age (yr)	45 ± 16	38 ± 13	< 0.001
weight (kg)	73 ± 14	74 ± 13	NS
sex (M/F)	54/46%	61/39%	NS
ASA (1/2/3)	50/39/11%	59/39/2%	NS
operating time (min)	40 ± 14	44 ± 15	NS
Operation:			
excise lesion tendon			
sheath	17%	17%	NS
fasciectomy	16%	13%	NS
tenonectomy	16%	9%	NS
arthroplasty	13%	6%	NS
arthrodesis	9%	5%	NS
reduction ± fixation			
fracture	6%	17%	< 0.05
remove hardware	3%	6%	NS
excise lesion wrist joint	3%	14%	< 0.05
miscellaneous	17%	13%	NS

non-percentage and count values are mean ± SD

TABLE III Cost

	IVRA	General anaesthesia	P
<i>Anaesthesia</i>			
supplies	\$ 7.71 (6.10–9.58)	\$ 5.00 (4.72–11.17)	< 0.00001
sterilizing	\$ 0 (0–1.27)	\$ 1.55 (1.27–1.55)	< 0.00001
drugs	\$ 9.83 (2.83–38.89)	\$ 18.25 (2.91–51.93)	< 0.00001
gases	\$ 0 (0–4.25)	\$ 6.88 (0.37–17.27)	< 0.00001
total	\$ 17.38 (10.54–48.68)	\$ 31.95 (20.73–60.88)	< 0.00001
<i>Recovery</i>			
supplies	\$ 0 (0–0.86)	\$ 0.31 (0–1.68)	< 0.00001
drugs	\$ 0.10 (0–1.04)	\$ 0.20 (0–2.44)	< 0.00001
nursing time	\$ 6.50 (3.18–22.32)	\$ 13.72 (6.32–27.31)	< 0.00001
total	\$ 6.61 (3.28–23.56)	\$ 14.51 (6.74–28.35)	< 0.00001
Grand total	\$ 24.60 (15.76–55.29)	\$ 48.66 (35.59–73.11)	< 0.00001

all values are median (range) in CANADIAN \$

Effectiveness data are shown in Table IV. Time taken to administer anaesthesia was the same in both groups. Unsatisfactory anaesthesia only occurred in the IVRA group. Supplementary local anaesthetic infiltration by the surgeon was needed in 7% of IVRAs, 2% of blocks had to be redone because of venous engorgement of the arm, and general anaesthesia was required in 2% (because of inadequate block in one patient, and inability to obtain intravenous access in the arm to be blocked in two patients).

Time spent in the PACU and from the end of surgery until discharge were both shorter in the IVRA group. No patient in either group required overnight admission. All postoperative complications that required treatment (or delayed discharge in the case of dizziness) are shown in Table IV. Vomiting and dizziness were more common in the group given general anaesthesia.

Discussion

A retrospective study in ambulatory patients demonstrated that the median total cost of anaesthesia and recovery in patients undergoing outpatient hand surgery at our institution was \$24.60 with IVRA, and this was half the \$48.66 cost of using GA. The two techniques required equal time to administer anaesthesia. Intravenous regional anaesthesia was associated with some failure in providing satisfactory anaesthesia compared with general anaesthesia, which was universally successful. Also, IVRA was more effective than general anaesthesia in terms of speed of recovery and discharge, and in having virtually no postoperative complications.

In the absence of valid comparisons of regional *vs* GA for ambulatory surgery it is difficult to justify an expensive, prospective, randomised study. A retrospective study, such as this, has an important role in the preliminary formulation and testing of a hypothesis as well as determining sample size estimates. Sampling bias was minimised by including all patients within a specified time frame and defining exclusion criteria. The two groups compared in this study were well matched despite the non-randomised, retrospective method used. The few differences between the groups would not be expected to have any important effect on the findings.

Costing of clinical services in individual cases is difficult,⁶ and only a few anaesthetic publications include references to cost despite recommendations to do so.¹ We attempted to conduct as detailed as possible a calculation of costs but were still required to make some estimates and assumptions in our analysis. The costs calculated for each group represent actual direct costs

TABLE IV Effectiveness

	IVRA	GA	P
anaesthesia time (min)	8 (2–23)	8 (1–25)	NS
unsatisfactory anaesthesia	7% local infiltration	0	< 0.01
	2% redo block		
	2% GA		
time in PACU (min)	43 (20–130)	77 (32–195)	< 0.00001
time to discharge (min)	70 (35–180)	118 (45–320)	< 0.00001
<i>Complications</i>			
vomiting	0	5%	< 0.05
bronchospasm	0	2%	NS
dizziness	0	5%	< 0.05
urticaria arm	2%	0	NS

non-percentage values are median (range)

PACU = post anaesthetic care unit

incurred by the institution and reflect the true costs of anaesthetic technique. Examining direct costs is a better way to compare economic advantages among techniques.⁷ Although the dollar value of the results we obtained is not directly applicable to other institutions the large difference in cost between the groups suggests that these results are generalizable and will be relevant to others using the same anaesthetic techniques. Interestingly, a preliminary, non-randomised study in another Canadian University Hospital yielded costs for IVRA of \$11.20 and for GA of \$24.40.⁸ Thus, the lower costs for IVRA obtained in our study are confirmed in another institution. It has been suggested that regional anaesthesia is more economical than general anaesthesia^{9,10} and this study quantifies the magnitude of these differences for outpatient hand surgery.

One other problem with the retrospective nature of this study is that patient satisfaction could not be measured. Patient preference is one of the main determinants of type of anaesthesia administered at our institution. Before recommending increased use of IVRA for its economic and recovery benefits it would be important to check that this does not lead to a decrease in patient satisfaction. In other studies of regional anaesthesia for shoulder surgery it was found that patient satisfaction was high (96%) when the success rate was 84%.¹¹ The success rate of IVRA in the present study was 89% and would be expected to be associated with a comparable patient satisfaction rate. It would also be necessary to ascertain if the level of supplementation and occasional need for general anaesthesia with this block is acceptable to surgeons, anaesthetists and patients and consider ways to improve the success rate of the block. Supplementary

sedation while facilitating patient acceptance of IVRA will also contribute to increased costs and may prolong recovery time.¹² One advantage of IVRA over other regional techniques is that factors such as technical proficiency, learning curve, attention to detail, motivation to succeed and confidence to sell the technique are not very important. In addition, IVRA is simple and fast enough to obviate the need for additional personnel and logistical arrangements to facilitate its performance outside the operating room.³

As with GA, potential complications with regional anaesthesia are numerous and there is substantial concern among anaesthetists about medico-legal implications. A perception that regional anaesthesia may be more likely to be associated with litigation has been substantiated by closed claims study.¹³ The most frequent regional techniques were spinal, epidural and axillary block. One advantage of IVRA is the low incidence of complications compared with other regional techniques and as shown in this study, with GA.

In conclusion, the cost of anaesthesia and recovery using IVRA for outpatient hand surgery was half that of general anaesthesia. IVRA was less effective than general anaesthesia in achieving satisfactory anaesthesia, equally effective in time to administer anaesthesia, and more effective in speeding recovery and minimising postoperative complications.

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