Occasional Review

The upgrading and replacement of anaesthetic equipment: a provincial approach

Robert M. Friesen MD FRCPC,*
Gill Hatton RTT (Anaesthesia),† Janet Bjornson BSc Pharm‡

A formal on-site survey of all anaesthetizing locations in the Province of Manitoba was initiated in the Spring of 1988. Serious deficiencies of anaesthetic equipment previously noted on random survey were confirmed. Recognizing a need for improved standards for delivery of anaesthetic services through safe, functional anaesthetic equipment, the province undertook to fund the upgrading of all anaesthetic gas delivery systems under its jurisdiction. Sixty-six hospitals were surveyed for a total of 203 anaesthetic machines (111 urban, 92 rural). One hundred and sixty-seven machines had been used at least once in the previous year. After careful assessment 92 machines were replaced, 66 machines were upgraded and 45 machines were deleted from further service. Although the maintenance and upgrading of medical equipment is the individual health care facility's responsibility, substantial benefit was recognized by a provincial approach. The authors recommend a similar approach for other Canadian provinces.

Au printemps 1988, on entreprit une inspection systématique de tous les appareils d'anesthésie par inhalation du Manitoba. Cela permit de confirmer les déficiences suspectées lors d'une précédente enquête sur échantillon. Reconnaissant l'importance de disposer d'équipements sûrs et fonctionnels pour améliorer le standard de qualité des soins anesthésiques, les autorités manitobaines décidèrent de rajeunir leur flotte d'appareils d'anesthésie. Des 203 appareils inspectés (dont 111 en milieu urbain) dans 66 hôpitaux, 167 avaient été utilisés durant l'année précédant l'inspection. On procéda à des améliorations sur 66 appareils et on remplaça 92 des 137 appareils mis au rancart. Même si la responsabilité de l'entretien et de la modernisation des équipements revient finalement à chaque hôpital, une approche intégrée à l'échelle provinciale s'est avérée rentable. C'est peut-être un modèle à suivre ailleurs au Canada.

Key words
EQUIPMENT: anaesthesia machines, exhaust systems, vaporizers, ventilators.

From the *Department of Anaesthesia, University of Manitoba, St. Boniface General Hospital, Winnipeg, Manitoba; †Health Sciences Centre, Winnipeg, Manitoba; ‡Urban Health Facilities Division, Manitoba Health Services Commission.

Address correspondence to: Dr. R.M. Friesen, Department of Anaesthesia, St. Boniface General Hospital, 409 Tache Avenue, Winnipeg, Manitoba R2H 2A6.

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In 1980 the Province of Manitoba Anaesthetic Machine Program was completed[1] to accommodate the then recent Canadian Standards Association Z168.3-M1980, "Continuous Flow Inhalational Anaesthetic Apparatus; (Anaesthetic Machines) for Medical Use."[2] Further Canadian Standards Association (CSA) publications have since been developed and released[3-4] which define more completely the operational standards for anaesthetic gas delivery systems. Subsequent to the 1980 program, informal surveys of anaesthetizing locations throughout the province suggested that serious anaesthetic equipment deficiencies continued to exist. In order to address this issue, a repeat, more intensive province-wide anaesthetic upgrade program was initiated in the spring of 1988.

Methods

A working committee was established in order to effect a province-wide upgrade. Formation of the Manitoba Anaesthetic Equipment Upgrade Program (MAUP) Advisory Committee included representation of urban and rural physicians involved in the active practice of anaesthesia, the Manitoba College of Physicians and Surgeons, the Manitoba Health Services Commission and the Manitoba Health Organizations, Inc. The mandate of the MAUP was to improve standards of care in regard to the administration of anaesthetic services in the Province of Manitoba through the appropriate provision of anaesthetic equipment. Patient monitors were not included in this

ANAESTHETIC EQUIPMENT SURVEY

Name of Facility:	Completed by:	
Position Title:	Date: Phone #:	
1. Machine Type:	2. Model:	
3. Purchase Date:	4. Location:	
5. Last Maintenance:	Completed by:	Inspection Frequency:
6. Hours of Use/12 months:	# of Anaesthetics/12 months:	
7. Gas Scavenging Equipment? ☐ Yes ☐ No ☐ Active ☐ Passive System	8. CO2 Absorber? ☐ Yes ☐ No Bypass? ☐ Yes ☐ No	
9. Back Bar Lockout? ☐ Yes ☐ No	10. Ventilator? ☐ Yes ☐ No	
11. Monitors: a) ECG ☐ Yes ☐ No	b) NIBP ☐ Yes ☐ No	
c) Oximetry ☐ Yes ☐ No	d) Capnograph ☐ Yes ☐ No	
e) Temperature ☐ Yes ☐ No	f) Oxygen analyzer ☐ Yes ☐ No	
g) Pressure Alarm ☐ Yes ☐ No	h) Spirometer ☐ Yes ☐ No	
i) Blockade Monitor ☐ Yes ☐ No		
12. Preventative Maintenance Program for Monitors? ☐ Yes ☐ No ☐ Monthly ☐ Semi-Annual ☐ Annual ☐ 3 Yrs ☐ 5 yrs		
13. Are CSA Standards Available in your Hospital? ☐ Yes ☐ No		
14. Other Related Equipment:		
15. Comments:		

FIGURE 1 Mail survey form. One form completed for each anaesthetic machine on site.

mandate although their presence on site was to be surveyed. Recognizing that substantial funding would be required to effect a province-wide upgrade, provincial funding was sought and approved prior to initiation of the program. All hospitals in the Province of Manitoba were included.

The process consisted of a mail survey followed by an on-site technical inspection of each anaesthetic machine. The on-site inspection also served to verify the information provided on the mail survey. The mail survey questionnaire sought information about the number of anaesthetic machines present, machine type and age, frequency of use, preventative maintenance arrangements as well as ancillary machine and patient monitors provided at each site (Figure 1). The on-site technical inspection verified the presence and function of the numerous components on a functioning anaesthetic machine which included appropriate DISS* fittings, medical gas hoses which were CSA colour-coded, gauges, medical gas cylinder pin-indexed yokes, oxygen fail-safe presence and function, oxygen flush mechanism, locking common gas outlet, back bar vaporizer lock-out mechanism, flow meters, vaporizers, ventilators, absorbers, breathing circuits and a CSA approved[4] waste anaesthetic gas scavenging system. The presence of functioning oxygen in-circuit analyzers, high/low pressure anaesthetic circuit monitors with alarms and provision for circuit spirometry were also recorded. All halothane vaporizers were subjected to an anaesthetic agent output check at a two per cent setting with a fresh gas flow of 4 $L \cdot min^{-1}$. Patient monitors such as an electrocardiogram, non-invasive blood pressure machine, pulse oximeter, capnograph and temperature monitor were noted on site but their frequency of use could not be verified. Preventative maintenance arrangements and records, preoperative check lists and the availability of equipment operating manuals were verified. All surveyed anaesthetic machines were photographed in at least two views. In those cases where major hazards were identified (example: back bar not connected to the vaporizer) the hospital was notified immediately, both verbally and in writing.

Each health care facility was provided with a detailed written report for every anaesthetic site surveyed. This report not only detailed the anaesthetic equipment present and its function, but also a recommendation for either upgrading existing equipment or its replacement. Recommendation for upgrading rather than replacement was based on the number of "faults" addressed, anaesthetic machine age, preliminary cost estimates as well as manufacturer assurance that parts and service would continue for upgraded machines. A representative MAUP survey summary and recommendation form is shown in Figure 2.

All data collected were filed in a computer registry at the Manitoba Health Services Commission.

In order to familiarize health care facility personnel with present and proposed CSA standards, the results of the on-site technical survey, and state-of-the-art anaesthetic equipment development, the MAUP hosted a one-day exhibition in Winnipeg. This also provided a forum for lecture and film presentations on pulse oximetry, capnography, pre-anaesthetic check lists and Canadian Anaesthetists' Society guidelines of practice.[5]

Health care facilities with very low case loads of general anaesthesia (less than 100 cases per annum) were requested to consider seriously the advisability of continuing such a service. Individual consideration was given for geographically isolated locations, specially approved provincial programs or university-affiliated remote northern surgical programs where staffing was provided by itinerant medical teams.

Once the MAUP recommendations had been carefully studied by each hospital and a consensus achieved of the

*Diameter index safety system.

ANAESTHETIC SITE EVALUATION SUMMARY*

HOSPITAL	
EQUIPMENT SURVEY #	
MACHINE	Ohio
MODEL	Unitrol
SERIAL NUMBER	ABDH___
BAR BACK LOCK	N
ABSORBER	Boyle 3
LOCKING COMMON GAS OUTLET	N
HALOTHANE VAPORIZER	Fluotec 3
ENFLURANE VAPORIZER	Ohio
ISOFLURANE VAPORIZER	N
O_2 ANALYZER	N
PRESSURE ALARM	N
SPIROMETER	N
VENTILATOR	Ohio Fluidic
DISS	Y
HOSES CSA COLOR	N
SCAVENGING	Y
SVG INTERFERENCE	N
TEMPERATURE	N
NERVE STIMULATOR	N
ELECTROCARDIOGRAM	Y
BLOOD PRESSURE	Y
OXIMETER	N
CAPNOGRAPH	N

N = Not present or not functional
Y = Present and functioning

RECOMMENDATIONS

- Upgrade anaesthetic machine subject to provincial tender pricing
- Requires locking common gas outlet, back bar lock out complete with two vaporizers, carbon dioxide absorber, ventilator, CSA approved waste gas scavenging interface and medical gas hoses
- Also requires oxygen analyzer, volume and pressure anaesthetic circuit monitor, temperature monitor, nerve stimulator
- Although not included in the funding of the MAUP, the availability of pulse oximeter and capnography are recommended at each anesthetizing location

* Hospital name and machine serial number deleted

FIGURE 2 Technical survey report. Representative anaesthetic site including site-specific recommendations for upgrade.

anaesthetic equipment to be upgraded, replaced or deleted, a group tendering process was initiated to encompass all anaesthetizing locations in the Province of Manitoba. Anaesthetic equipment manufacturers with a local provincial presence were invited to bid on fulfilling the anaesthetic site specific recommendations of the MAUP. This process was coordinated through the offices of the Manitoba Health Organizations, Inc. Hospitals were encouraged to utilize this process to acquire additional anaesthetic equipment or machine features not included in MAUP funding in recognition of the anticipated monetary savings by group purchase. Major manufacturers invited to tender included Penlon, Drager and Ohmeda.

Results

Urban health care facilities in Manitoba are confined to the cities of Winnipeg and Brandon and all have more than 130 active treatment beds. Rural hospitals, as defined by the Manitoba Health Services Commission, are located outside the above cities, range in size from four to 105 active treatment beds and service communities of less than 20,000 population each.

Sixty-six hospitals (8 urban, 58 rural) were surveyed for a total of 203 anaesthetic machines (111 urban, 92 rural). The number of active machines (used at least once in the past year) was 167. Seven machines were designated as malignant hyperthermia standby units. Anaesthetic machines were located in the emergency rooms of three rural health care facilities although the previous upgrade had not recommended this practice. The number of active anaesthetic machines identified in 1980 was 195. Several anaesthetic machines never approved for sale in Canada or thought to have been deleted in the 1979 upgrade program continued to be in active service.

Ninety-five per cent (193/203) of the mail survey forms were returned after telephone follow-up. Sixty-two per cent (120/193) were completed and returned with correct information. Five per cent (10/193) were completed with such inaccuracy and error as to be deemed totally unreliable.

Fifty-nine per cent of the anaesthetic machines surveyed had been manufactured between 1970–80, while seven per cent were manufactured before 1970 and 34 per cent after 1980. Vaporizers surveyed on the 167 active machines included halothane (n = 165), enflurane (n = 73), isoflurane (n = 91) and methoxyflurane (n = 5). Ether bottles were noted on the back bar of three anaesthetic machines. A back bar lock-out device was present on 26 per cent (43/167) of the machines surveyed. One hundred and thirty-four anaesthetic patient ventilators were identified and classified according to bellows function as well as circuit alarms present (rising bellows = 74, hanging bellows = 56, internal factory pre-set low pressure alarm = 116, separate circuit pressure monitor = 55).

A waste anaesthetic gas scavenging system was identified on 86 per cent (145/167) of the machines surveyed; however, only 36 per cent of these devices were CSA-approved devices which included a waste anaesthetic gas scavenging interface. Thirty-one health care facilities provided for paediatric anaesthetic services of which 55 per cent provided for scavenging of waste anaesthetic gas. Less than one-half of the health care facilities surveyed could provide information on the mechanics of their operating room ventilation systems or the estimated number of fresh air exchanges provided to each suite.

Fourteen anaesthetic machines in service received no regular preventative maintenance; however, only one of these was being used on a regular weekly basis. Preventative maintenance arrangements in place at the time of the MAUP survey are summarized in Table I.

The monitoring devices available with each active anaesthetic machine are documented in Table II.

TABLE I Preventative maintenance arrangements

No regular preventative maintenance	14
Factory personnel	82
Independent private contractor	68
In-hospital technicians	39
Total	203

TABLE II

A *Anaesthetic machine monitors/alarms*		
Oxygen monitor (FiO_2)	110/167	66%
Ventilator low-pressure alarm	116/134*	87%
Separate circuit high/low pressure monitor	55/134*	41%
Spirometer	70/167	42%
Oxygen pressure fail safe (†)	167/167	100% (98%)
B *Patient monitors*		
Electrocardiogram	12/167	74%
Automated non-invasive B.P.	121/167	72%
Temperature	75/167	45%
Nerve stimulator	112/167	67%
Pulse oximetry	44/167	26%
Capnography	10/167	6%

(n = 167 active anaesthetic machines surveyed)
*Machines equipped with ventilator.
†Present on all machines; however, 4/167 had significant operational faults as to make them ineffective.

Although informal conversation with physicians practising anaesthesia throughout the province suggested a high utilization of pre-use machine checks, only 17 per cent of the anaesthetic sites surveyed could provide a pre-use check list. Many of the anaesthetic machine functional faults demonstrated at the time of our technical on-site survey (Table III) would have been detected by the use of a comprehensive routine pre-use check list. We do not have any information on whether any of these listed faults resulted in adverse patient outcome although the potential was there for such adverse events to occur.

The ingenuity of local maintenance personnel without regard to and/or knowledge of present CSA standards as well as the "I'll make do" philosophy of many practising anaesthetists resulted in some potentially dangerous anaesthetic machine set-ups (Table IV).

The MAUP-hosted product exhibition was very well received by 138 registrants. The majority of registrants were from rural Manitoba. This exhibition, as well as local manufacturer sales representative activity, facilitated individual hospital participation in equipment selection.

Forty-nine urban anaesthetic machines were upgraded, 54 urban anaesthetic machines were replaced while eight were deleted from further use. Twenty rural health care facilities ceased to provide anaesthetic services and in most cases the anaesthetic equipment on-site was removed. Seventeen rural anaesthetic machines were upgraded while 38 rural anaesthetic machines were replaced. Thirty-seven rural anaesthetic machines were deleted from further service. Table V summarizes this data.

TABLE III Anaesthetic machine functional faults[1]

High-pressure leaks[2]	24/167
Low-pressure leaks[3]	11/167
Non-functioning oxygen fail sate	4/167
Regulator malfunction	4/167
No emergency oxygen supply[4]	2/167
Inaccurate halothane vaporizer output[5]	2/165

[1]167 active anaesthetic machines.
[2]Greater than 100 PSI pressure loss over five minutes.
[3]Less than 50 ml flow to maintain pressure at 22 mmHg with occluded fresh gas outlet or 15-second negative bulb test.
[4]Oxygen yoke inlet occluded by plastic protector cap which had not been removed.
[5]Greater than ten per cent error in vaporizer output when dial set at two per cent.

Many of the no or low anaesthetic case load facilities welcomed the opportunity to rid themselves of the responsibility of continuing to maintain anaesthetic equipment. These facilities did not perceive a demand for such service and frequently had no documented anaesthetics adminstered in the past one to five years.

All anaesthetic equipment identified as obsolete has now been designated as NOT FOR PATIENT USE in Manitoba. Disposal of such equipment included:

i Dismantling of equipment with physical destruction of various components (n = 22). A destruction certificate was provided for each machine destroyed.
ii Retained on site but clearly marked as not for patient use (n = 3)
iii Donation of equipment to third world mission health care facilities (n = 5).

TABLE IV Anaesthetic machine set-ups which could result in adverse patient outcome

– "H"-size nitrous oxide cylinder with oxygen regulator, green high-pressure hose and DISS (oxygen) couplers to nitrous oxide inlet of anaesthetic machine	(1)
– Numerous plastic washers left on yoke inlet so as to defeat the pin index system	(3)
– Oxygen DISS coupler on nitrous oxide high pressure hoses	(2)
– "Home made" anaesthetic circuits often utilizing Ruben valves (connections frequently affected by tape)	(6)
– Carbon dioxide absorber by-pass valve taped in permanent "off position"	(2)
– Portable vaporizer downstream from common fresh gas outlet	(3)

( ) Number of sites at which inappropriate set up noted.

TABLE V Anaesthetic machine disposition

	Urban	*Rural*	*Total*
Anaesthetic machines at initial survey	111	92	203
Anaesthetic machines at upgrade completion	103	55	158
Anaesthetic machines replaced	54	38	92
Retrofit upgrade	49	17	66
Anaesthetic machines deleted from service	8	37	45

iv Utilization of obsolete equipment by animal research facilities (n = 6)

v Utilization of obsolete equipment by local veterinarian clinics (n = 9)

User preference, warranties, service contracts, continuing preventative maintenance as well as price were all determining factors in the awarding of the MAUP contracts for replacement or upgrade (Table VI). Anaesthetic machines designated as malignant hyperthermia standby units were upgraded or replaced as required although this may no longer be necessary.[6,7]

Cost savings recognized by tendering on a provinical basis were substantial. Although further saving could have been effected by eliminating user preference from the formula for contract award, it is estimated that the cost saving over retail was between 41 and 45 per cent on new anaesthetic machine purchases alone. The cost of this program, including technical and administrative fees, was 3.2 million dollars.

TABLE VI MAUP contracts awarded

Anaesthetic machines replaced (total = 92)

Manufacturer	*Model*	*n*
Ohmeda	Modulus II Plus	45
Ohmeda	Excel 210	3
Ohmeda	Excel 310	3
Drager	Narkomed 2B	34
Drager	Narkomed 3	7

Anaesthetic machines upgraded (total = 66)

Company providing upgrade	*Machine make/model*	*n*
Ohmeda	Ohio Unitrol	33
	Boyle MS	21
	Boyle 8000	6
Drager (Brathwaites-Olivier*)	Narkomed	2
	Narkomed 2A	1
Penlon (Medigas*)	Ohio Unitrol	1
	Penlon AM 1000	2

*Local manufacturer representative.

Discussion

The Canadian Anaesthetists' Society, the Canadian Standards Association as well as numerous similar American regulatory agencies and medical societies continue to strive for higher standards with regard to anaesthetic equipment manufacture, anaesthetic equipment upgrade as well as the routine utilization of appropriate monitoring devices.[5,8,9] Our survey would suggest that these guidelines are not well followed. Serious equipment deficiencies were identified in both urban and rural health care facilities. Similar inadequacies of anaesthetic equipment were identified by Kumar *et al.*[10] in the State of Iowa. The MAUP differed from that of Kumar *et al.* in that the present survey was not random but included all hospital anaesthesia locations. The MAUP not only identified deficiencies but sought to remedy them on a provincial basis in spite of the cost implications.

Equipment-related anaesthesia incidents continue to be reported in the medical literature.[11-14] Cooper *et al.*[14] suggested that technologically related improvements as part of serious incident-prevention strategies would have been effective in 18 of 70 incidents which they investigated. Incidents involving the breathing system account for the largest category of equipment-related anaesthetic morbidity and mortality.[12] Technologically related improvements can improve the standard of patient safety.[11] The role of improved training in technology, the use of preoperative check lists, hospital-administration awareness and increased anaesthesia professional society activity are of equal or even greater importance to sustain further improvements in safety for the anaesthetized patient.

With the dialogue that surrounded the creation of the MAUP it was evident that there were many issues other than just the physical upgrading or replacement of anaesthetic equipment which would have to be addressed in order to influence the practice of anaesthesia in Manitoba. These issues and their subsequent resolution included:

1 *Was it appropriate to upgrade or replace all present anaesthetic equipment whether or not it was being utilized?*

The MAUP Advisory Committee unanimously agreed that it was not. Only anaesthetic equipment that was clearly identified for specific use was considered in the upgrade program. Preventative maintenance costs make the retention of unused or under-utilized anaesthetic equipment prohibitive. At the time of tendering this upgrade program, the lowest estimated bi-annual preventative maintenance contract was costed at $1230 p.a. per machine. The preventative maintenance costs saved by the deletion of 45 anaesthetic machines from service (Table V) is then at least $55,350 per annum. The above estimate does not include initial capital expenditure,

subsequent upgrade costs,[15] finance charges or anticipated annual increases in service costs.

2 *How wide a scope should the anaesthetic survey and subsequent upgrade have?*

Ideally, all anaesthetic gas delivery systems in the Province of Manitoba should have been included in this program. All provincial health care facilities as well as two federally funded hospitals were included. Although the MAUP did offer its technical on-site survey to several privately funded day-surgery clinics as well as the Manitoba Dental Association, these groups did not avail themselves of this no-charge service. The College of Physicians and Surgeons of Manitoba subsequently sent an information letter to all physicians practising anaesthesia in Manitoba concerning the inadvisability of practising in facilities not approved by the College. One may speculate that equipment deficiencies and insufficient monitoring of equal or greater magnitude to that revealed by this study could be present in these non-hospital settings. A recent report by Davies and Campbell[16] confirms such speculation.

3 *What should be done with facilities where anaesthetic equipment was present but utilized infrequently?*

This represented the greatest challenge to the MAUP Advisory Committee. A trend to regionalization of surgical and anaesthetic services was evident.[17] The 1980 program identified 195 anaesthetic machines in active service while this number was 167 in 1988. Five anaesthetic machines replaced in the 1979–80 upgrade program had never been used. Although the MAUP Advisory Committee was primarily concerned with standards of anaesthetic equipment it was not possible to avoid the issue of appropriate safe utilization of anaesthetic equipment. All facilities with a total anaesthetic patient case-load of less than 100 cases per annum were reviewed in detail. In 1979–80, facilities with a recorded anaesthetic case load of 40 per annum were automatically upgraded. As previously stated, individual consideration was given to health care facilities with specially approved programs serviced by itinerant medical speciality teams.

4 *What should be done with old or obsolete anaesthetic equipment?*

The MAUP Advisory Committee considered that obsolete equipment should be identified. The issue has recently been addressed by the Anaesthesia Patient Safety Foundation.[18,19] Obsolete equipment, for the purposes of the Upgrade Program, was defined as any piece of anaesthetic equipment which could not be upgraded to include the intent of recent CSA standards or where such an upgrade was impractical on the basis of cost, physical anaesthetic machine design or an uncertain future parts supply. The medicolegal liability concerning the utilization of obsolete equipment by the veterinarians was expressed by Ohmeda representatives.

Specific documentation of obsolete equipment disposal was considered necessary based on previous experience in Manitoba. Several anaesthetic machines designated for deletion in the 1979–80 upgrade program were identified in active service with the present survey. According to information received from Ohmeda the Boyle Model 50 was never authorized for sale in Canada. Three Boyle 50 anaesthetic machines were identified in service in Manitoba.

5 *What were the benefits of a central registry of all anaesthetizing locations and equipment?*

The MAUP felt that such a system was merited. Heightened public awareness as well as the institution of quality assurance programs suggest that hospitals have a responsibility to maintain and possibly enhance medical equipment on site.[15] Our survey suggests that this does not happen.

A central registry would provide each participating health care facility with a mechanism whereby:

a Medical device warning and information bulletins could be forwarded.

b The cost implications of future anaesthetic equipment enhancements could be made.

c Future anaesthetic equipment tendering processes could be facilitated in the maintenance of consistent anaesthetic equipment standards.

In spite of the impact that the MAUP has had, there were a number of limitations in its implementation. The survey was not all-inclusive as dental and private clinic anaesthetizing sites did not participate in the survey. It was also possible for a health care facility to disclose incompletely the number of anaesthetic gas delivery systems present and so it is still possible that some obsolete machines are operational in the province. Federally funded health care facilities were reluctant to participate in the upgrade process but did so eventually.

The completion of a provincial upgrade program of this magnitude is of mixed benefit. Heightened medical, public and hospital administration awareness of the speciality of anaesthesia is inevitable. The danger lies in assuming that this is a one-time, permanent solution. Technological advances are expected to continue and their impact on the safe practice of anaesthesia will need to be assessed continually.[15]

A province-wide tendering process, by design, results in some equipment manufacturers being excluded from being represented in the market place. Previous experience with the awarding of the 1979–80 upgrade program

to a single vendor was not favourable. Therefore, user preference, local provincial representation, preventative maintenance contracts as well as price were considered before any tender awards. Many hospitals were dissatisfied with the manufacturer service and sales which had been provided previously and they sought the services of an independent third party. Our evaluation of this arrangement was that it provided an exceptional service, especially to remote rural communities.

At the time of implementation, the MAUP did not have a mandate or the funding to include provision of patient monitors such as electrocardiograms, non-invasive blood pressure devices, pulse oximetry or capnography. Ideally, the provision of physiological monitors for the anaesthetized patient as recommended by the Canadian Anaesthetists' Society[5,8,9] could have been made at the same time.

In summary, the MAUP provided a cost-effective means of implementing a province-wide upgrade of all hospital-based anaesthetic equipment. This process resulted in a consistent standard of anaesthetic equipment available throughout the province. The provincial trend to regionalization of health care is now also reflected in health care facilities which provide anaesthetic services. Further evolution of this process is sure to occur.

Although legislated responsibility for the maintenance and upgrading of equipment rests with each individual health care facility, a provincial approach is preferable. We would recommend such a program for other provinces.

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