Reducing the costs of ICU admission in Canada without diagnosis-related or case-mix groupings

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A prospective analysis of the cost of intensive care was carried out on 67 admissions to a multidisciplinary ICU. Admissions were grouped and investigated according to various criteria such as admitting diagnosis, admission status (elective vs emergency), severity of illness and outcome. Total ICU admission costs, total per diem ICU costs and per diem costs divided into fixed and variable cost items for the patient groups are reported. Lower total and per diem ICU charges were observed for elective surgical patients, patients with lower severity of illness as assessed by the Therapeutic Intervention Scoring system and survivors. Emergency admissions were more expensive than elective admissions when compared for total ICU admission costs. Length of stay was a significant factor in overall ICU costs. Within the variable cost items, the diagnostic laboratory was the single most costly item per day. As a result of this analysis, the authors propose several suggestions for reducing ICU costs independent of case-mix or diagnosis-related groupings of ICU patients.

Key words
INTENSIVE CARE: COSTS.

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The rapid development and general availability of advanced biomedical technology and pharmacology has allowed the medical profession to maintain life in progressively sicker patients but at an ever-increasing financial cost. During the last ten years, the documentation of spiralling costs of general medical and surgical care has resulted in the evolution of several cost containment systems such as the diagnosis-related groupings (DRG's) in the United States[1] and the case-mix groupings (CMG's) in Canada.[2] These prepayment schemes are designed to reimburse hospitals on a fixed-charge system based on diagnosis rather than the previous global cost-based hospital system.[1]

Critically ill patients admitted to the Intensive Care Unit (ICU) consume a major portion of hospital resources. Although admitted to the ICU for only 15–19 per cent of their entire hospital stay, this small number of patients has been reported to generate 40 to 60 per cent of their total hospital charges as a result of ICU admission.[3,4] We felt that prior to the use of any cost saving strategies for patients in the ICU, the actual costs incurred for various therapies, medications and diagnostic procedures must be documented and related to various patient characteristics. In particular, we were interested in the variation of cost with severity of illness, admission status and outcome factors which most prospective payment schemes fail to adequately consider for the ICU population.[5,6]

It was the purpose of this report to investigate the total ICU admission costs and the daily costs of a group of patients classified according to various patient characteristics. Several direct questions were asked: did costs vary with admitting diagnosis, with severity of illness, with admission status (elective or emergency), or with outcome? Based

TABLE I Basis for patient grouping

Diagnostic criteria:		
Monitoring admission (MA)	[n = 20]:	TISS <20 regardless of diagnosis
Elective cardiac surgery (CARDIAC)	[n = 10]:	7 coronary artery bypasses, 3 cardiac valve replacements
Major trauma (TRAUMA)	[n = 10]:	All blunt trauma, ISS >16
Emergency vascular surgery (VASCULAR)	[n = 10]:	9/10 ruptured aortic aneurysms. One ruptured popliteal aneurysm
Gastrointestinal bleed (GI BLEED)	[n = 10]:	All peptic ulcer bleeds; 7-duodenal, 3-gastric
Acute respiratory failure (ARF)	[n = 7]:	All ventilated (non-surgical)
Patient characteristics:		
Severity of illness:		
Low [TISSLO (n = 26) = TISS < 24] versus high [TISSHI (n = 41) = TISS > 24]		
Admission status:		
Elective (n = 15) versus emergency (n = 52) admission		
Outcome:		
Survivors (n = 53) versus nonsurvivors (n = 14)		

on this analysis, several simple suggestions are made to help reduce ICU admission costs.

Methods

This study was carried out in the 15-bed, open, multidisciplinary ICU of the Kingston General Hospital. It is the only medical/nursing unit in the 500-bed teaching hospital providing mechanical ventilation. The nurse to patient ratio is 1:1.

During the period June 1 to September 1 1984, 251 patients were admitted to the ICU. From this prospective population, 67 patients, comprising six general diagnostic categories as defined below, were randomly selected for cost analysis. Patients identified as major trauma were further assessed by the Injury Severity Score (ISS).[7] An ISS of 16 or greater is generally a major multisystem trauma. All patients entering the study had severity of illness estimated by the Therapeutic Intervention Scoring System (TISS) recorded on the day of admission.[8] TISS provides an objective measure of severity of illness by assigning points for each treatment and monitoring intervention used to support unstable physiological variables. More invasive procedures result in higher raw scores. Interventions are summed to give a total TISS value reflecting relative severity of illness. The average ventilator-dependent patient requiring frequent arterial blood gas determinations scores approximately 25–28 points. Non-ventilated, monitored patients usually score 15–20 points. This evaluation requires 12–15 minutes of time per patient when done by experienced observers.

Financial data for individual patient use of hospital resources was determined by the results of the Case Mix Management system of the Kingston General Hospital.[2] This cost accounting system previously evaluated the ICU and provided detailed costs for admitting, medical records, general hospital administration-financial services ("hotel" costs), radiology, blood bank, chemistry, microbiology, haematology, renal dialysis, nursing, respiratory therapy, physiotherapy, clerical, direct supplies, and all pharmacy medications, including total parenteral nutrition (TPN). Individual patient costs were identified by an intensive chart analysis of the selected ICU admissions. Nursing assignments for all patients were 1:1 (nurse:patient). ICU expenditures could then be divided into:

Fixed costs
- nursing,
- clerical,
- administraiton,
- admitting department,
- medical records and "hotel" costs.

Nursing costs are designated as fixed due to the

TABLE II Comparison of diagnostic groups by length of stay, mortality and severity of illness

Diagnostic group	*No.*	*Length of stay (days)*	*TISS (pts)*	*ICU mortality (%)*	*Total cost ($)*
MA	20	2.0 ± 3.0[a]	20.4 ± 2.6[a]	0	1665 ± 2237[a]*
CARDIAC	10	2.5 ± 0.5[a]	49.4 ± 4.0[b]	0	2386 ± 3571[a]
TRAUMA	10	8.0 ± 9.0[b]	47.6 ± 8.8[b]	20	8389 ± 9189[b]
VASCULAR	10	9.8 ± 8.5[b]	57.2 ± 9.9[b]	40	9578 ± 7813[b]
GI BLEED	10	6.0 ± 5.0[b]	49.0 ± 14.0[b]	60	5490 ± 4391[b]
ARF	7	13.0 ± 12.0[b]	42.6 ± 8.8[b]	29	11495 ± 10392[b]

*Comparisons are between the diagnostic groups. The means of the various diagnostic groups with different superscripts are statistically different from one another by ANOVA.

established 1:1 nursing policy for all patients in the ICU.

Variable costs

- consultations (respiratory therapy, physiotherapy),
- pharmacy medications/TPN,
- direct supplies,
- laboratory costs (haematology, chemistry, microbiology),
- radiology costs,
- blood bank costs.

These costs are the result of diagnostic and treatment decisions made directly by the physicians involved in the patients' care and because they vary day to day, they were assigned to the variable cost category. Charges outside the ICU, such as emergency room, operating room or postanaesthetic recovery room costs were not included. Physician fees billed to the provincial health care plan by the various attending physicians and resident physicians salaries were not included.

The 67 patients were grouped based on two criteria, as shown in Table I. Based on these patient characteristics, the cost analysis was divided into total ICU costs and total per diem ICU costs. Within the total per diem ICU cost analysis, a detailed reporting of fixed versus variable daily charges was done.

Statistics

All data are recorded as the mean ± standard deviation. Data analysis proceeded first by classifying data sets as parametric (normal distribution) or nonparametric (skewed distribution). Comparisons of the means of multiple groups were done by Duncan's multiple range analysis (parametric) or the Kruskal-Wallis modification (nonparametric) of the analysis of variance (ANOVA).[9] Other two sample comparisons were done using an unpaired t-test or the Mann-Whitney Signed Rank test.[10] A significance level of $F < 0.05$ or $p < 0.05$ was used.

Results

Total ICU cost

The length of stay, average admission TISS, mortality and average total ICU admission cost was compared between diagnostic groups and is shown in Table II. The total cost of ICU admission for the MA and CARDIAC groups was significantly less than any other diagnostic group based almost exclusively on a shorter length of stay. Table III displays a similar comparison based upon the patient characteristics of severity of illness, the admission status, and outcome. TISSHI, EMERGENCY and NONSURVIVOR groups were all significantly more expensive. The length of stay was significantly extended for the EMERGENCY and TISSHI groups only.

Per diem cost of ICU

This analysis consisted of a calculation of the fixed and variable costs per day as previously decribed. The fixed costs for all patients regardless of patient category were $639 ± 5 per day. This was almost entirely due to nursing labour costs as a result of nursing assignments of 1:1 (nurse:patient) as well as fixed hospital costs (admitting, medical records, etc). Therefore, variable costs exclusively accounted for the changes observed in the total per diem charges.

TABLE III Comparison of patient characteristics by length of stay, severity of illness, mortality, and total cost

Characteristic	*No.*	*Length of stay (days)*	*TISS (pts)*	*ICU mortality (%)*	*Total cost ($)*
Severity of illness					
TISSHI	46	7.5 ± 8.4*	50.0 ± 10.4*	31*	7274 ± 7881*
TISSLO	21	3.2 ± 2.2	20.9 ± 3.2	0	1786 ± 2255
Admission					
Emergency	42	7.9 ± 8.7*	46.0 ± 15.0	33*	7660 ± 8164*
Elective	25	2.1 ± 0.8	40.3 ± 13.3	0	1930 ± 724
Outcome					
Non-survivors	14	7.7 ± 8.0	57.1 ± 13.5*	100	7865 ± 7271*
Survivors	53	5.3 ± 7.3	36.6 ± 13.9	0	4959 ± 6961

*Comparisons are between individual patient characteristics.
Significant by unpaired T or Mann-Whitney test $p > 0.05$.

TABLE IV Comparison of diagnostic groups by individual variable costs and total/day costs

	MA ($)	*CARDIAC ($)*	*TRAUMA ($)*	*VASCULAR ($)*	*GI BLEED ($)*	*ARF ($)*
Consults	24 ± 34^{a}	57 ± 16^{a}	43 ± 26^{a}	49 ± 34^{a}	47 ± 48^{a}	$43 \pm 7^{a*}$
MEDS/TPN	15 ± 15^{cd}	4 ± 5^{d}	55 ± 54^{ab}	88 ± 44^{a}	45 ± 30^{bc}	61 ± 42^{ab}
Supplies	48 ± 30^{bc}	106 ± 19^{a}	94 ± 24^{a}	66 ± 84^{ab}	51 ± 35^{bc}	22 ± 14^{c}
Lab	87 ± 40^{b}	154 ± 31^{a}	142 ± 58^{a}	180 ± 36^{a}	172 ± 68^{a}	158 ± 25^{a}
Radiology	39 ± 32^{b}	53 ± 7^{b}	108 ± 35^{a}	64 ± 20^{b}	51 ± 33^{b}	54 ± 14^{b}
Blood bank	19 ± 15^{b}	7 ± 2^{b}	21 ± 15^{b}	70 ± 80^{a}	64 ± 49^{a}	18 ± 13^{a}
Total/day	877 ± 77^{b}	1019 ± 68^{a}	1104 ± 77^{a}	1159 ± 269^{a}	1070 ± 162^{a}	985 ± 97^{a}

*Comparisons are between the diagnostic groups for a particular variable cost item. The means of the various diagnostic groups with different superscripts are statistically different from one another by ANOVA.

COSTS BY DIAGNOSTIC GROUP

Comparisons of the variable charges for consulations, laboratory, etc., were made based on diagnostic criteria and are illustrated in Table IV. The MA group was significantly different from all other diagnostic groups for total per diem cost. The single most expensive variable item was the diagnostic laboratory. The analysis further reveals four statistically different diagnostic groups for medication and TPN, three for direct supplies and two for laboratory, radiology and blood bank.

COSTS BY PATIENT CHARACTERISTICS

Comparisons of the variable charges as assessed by the patient characteristics of severity of illness, admission status, and outcome are shown in Table V.

Severity of illness

TISSHI admissions were more costly per day than TISSLO. This difference persisted for all variable items except the blood bank.

Admission status

Total per diem costs of emergency admissions were not significantly different from elective admissions. Emergency patients required significantly more medication and TPN, whilst elective patients required more direct supplies.

Outcome

Nonsurvivors were more expensive than survivors for overall per diem costs and all variable costs except direct supplies.

TABLE V Comparison of total per diem and variable costs in ICU for admission type, severity of illness and outcome criteria

	Severity of illness		*Admission*		*Outcome*	
	TISSHI ($)	*TISSLO ($)*	*Elective ($)*	*Emergency ($)*	*Survivors ($)*	*Nonsurvivors ($)*
Consults	48 ± 32	25 ± 33*	38 ± 30	41 ± 35	34 ± 28*	66 ± 42
MEDS/TPN	50 ± 48	15 ± 14*	11 ± 12*	47 ± 46	31 ± 40*	77 ± 40
Direct supplies	71 ± 53	46 ± 30*	92 ± 26*	56 ± 51	60 ± 40	78 ± 72
Lab	162 ± 49	90 ± 41*	131 ± 43	150 ± 63	126 ± 49*	192 ± 57
X-ray	66 ± 33	40 ± 32*	53 ± 12	60 ± 39	54 ± 33*	75 ± 38
Blood bank	38 ± 53	18 ± 15	15 ± 14	41 ± 55	23 ± 29*	65 ± 75
Total per diem	1076 ± 167*	879 ± 75	985 ± 24	1051 ± 193	967 ± 107	1193 ± 234*

*Comparisons are between the various patient characteristics for a particular variable cost item. $p < 0.05$ by unpaired t-test or Mann-Whitney.

Discussion

It would appear that the answers to the original questions are dependent to a certain extent upon the type of analysis that is performed. Diagnostic category did not affect the per diem cost but the total admission cost was influenced by this factor based entirely on longer admissions. Certain patient characteristics did influence ICU costs. Severity of illness was directly related to increased daily and overall ICU costs. Nonsurvivors were more costly than survivors in all respects despite similar lengths of stay. The total ICU admission cost of emergency admissions was greater than elective admissions.

These data indicate that any prepayment scheme developed for patients who require ICU therapy based on diagnostic criteria may falsely represent ICU costs, even if the length of stay for that diagnosis is accurately determined. More importantly, severity of illness, type of admission and outcome, factors which are often neglected in the cost reducing strategies, have been shown in this report to directly affect ICU charges. These factors must be considered in the development of prospective payment plans for any ICU patient.[5,6]

In the only other Canadian study examining costs of ICU, Byrick *et al.* in 1980 reported a cost analysis of acute respiratory failure of varying etiologies in 58 patients.[11] These authors included physician fees for services rendered to these patients in the ICU as well as anaesthetic and surgical procedural fees. The average cost in Byrick's study for a survivor was $4296 (no standard deviation) and for a nonsurvivor was $6305 (no standard deviation) with an average length of stay of 7.7 ± 1.7 days. Although TISS points were recorded, no breakdown of costs based on this factor was attempted. Our costs and length of stay are not very different from this five-year-old study. Because we were solely interested in ICU costs, physician, anaesthetic and surgical fees were not reported and we avoided the bias of increased expenditures for the pure surgical patients seen in Byrick's study.

Fixed costs were over half of the daily cost of an ICU stay and for the most part were the result of direct labour charges. This cost item remains fixed based primarily on the committment of the nursing staff to a 1:1 nurse to patient ratio.

The largest portion of the daily variable cost was for laboratory services. It was enlightening to discover that the average ICU patient each day underwent eight arterial blood gas measurements, six electrolyte and three haemoglobin determinations! There was little difference between items based on diagnostic group if the MA group is excluded. These data agree with both Civetta[3] and Parno[12] who have reported that diagnostic tests were one of the single most costly items incurred in the ICU. Based on his own analysis, Civetta developed an ICU cost reduction strategy focused almost entirely on laboratory use. This scheme maintained the quality of medical care rendered and resulted in a saving of over $3000 US per patient per admission.

Exclusive of the diagnostic and treatment items, the other major factor determining the total charge of an ICU admission is the length of stay. It is not surprising that the ARF, VASCULAR, TRAUMA and GI BLEED patient groups had higher total ICU

costs based on their significantly longer lengths of stay when compared to either the CARDIAC or MA groups. Similar data from the United States has been reported in cost analyses of ICU patients based on various patient characteristics.[12–18] In this regard, Fedullo's study suggesting that increased age is directly related to increased mortality and reduced ICU costs based on shorter lengths of stay deserves comment. Our own analysis of age and ICU outcome of 481 patients revealed that age by itself was not a reliable factor in predicting outcome from ICU admission.[19] Poor physiological status, emergency admission status combined with age were far more sensitive predictors of survival. Moreover, it has been our personal observation that attending physicians are more readily able to accept an inevitable outcome of death in a critically ill elderly patients and withold further aggressive, life-prolonging interventions as multiple body systems begin to fail when compared to a similar group of younger patients.

It was not the purpose of this report to compare ICU costs as we actually recorded them versus the costs as predicted by CMG or DRG analysis. We are unable therefore to comment on the validity of such systems as applied to the ICU. However, based on our results it appears that several simple suggestions may be put forward to reduce the dollar costs of ICU admission without apparent loss of the quality of care and without the use of CMG's or DRG's.

Reduce variable costs

This strategy would attempt a reduction in the most costly daily variable items, namely the use of the diagnostic facilities. Physicians in the ICU must be constantly reminded of the costly nature of routine daily investigations which frequently do not result in a change of therapy.[20] We believe that there should be no standing orders for *x*-ray or laboratory investigations. All orders in the ICU should be written as Civetta suggests: one order-one test.[3] Despite the variety of political arrangements for care in the ICU (open, closed, semi-open, etc.) only specified physicians should actually write orders. This would reduce duplication of investigations. Above all, physicians must be encouraged to use deductive reasoning in the approach to clinical problems in the ICU patient. This would avoid frequent use of the "umbrella" phenomenon of indiscriminate laboratory testing hoping to find an unexpected laboratory result to explain a relevant clinical finding.

Reduce fixed costs

This alternative would reduce fixed costs by decreasing the nurse-to-patient ratio to less than 1:1. This has been proposed as a potential application of TISS, wherein a skilled ICU nurse should be able to effectively handle 40–50 TISS points on a daily basis. Hence, nursing shift complements would be based on total ICU TISS points rather than the number of admitted patients.[8]

Reduce length of stay

It is obvious that a major factor in overall ICU cost is the length of stay for a given admission. In order to reduce this factor, patients would have to be discharged from the ICU to patient care facilities wherein nursing care time and the use of diagnostic facilities is less. The use of so called step-down units may aid in this regard. The application of a minimum TISS point total required for discharge from ICU and admission to the step-down unit would be helpful.

Define a minimum severity of illness for admission

This strategy would require the stablishment of a unique, locally determined "floor" value of severity of illness using measures such as TISS or alternatively, physiological variable assessment by APACHE II[21] which would be necessary to gain ICU admission. On a daily basis, such a score could also be used to objectively define discharge criteria and hence potentially reduce length of stay. Our current experience with APACHE II and TISS in over 1000 patients indicates that APACHE II can be done reliably by novice medical observers in five to seven minutes per patient. Admittedly TISS requires a longer period of time to do and must be recorded by experienced personnel. Such measures could eliminate some admissions to ICU for "monitoring purposes."

Most physicians believe that significant cost savings can be realized in the management of intensive care patients. The quality of medical care should not decrease as a result of these policies. We believe that the acceptance and broad application of any cost containment system should not be viewed as an isolated administrative policy decision. These

economic concerns are confounded by complex legal, moral and societal issues in the care of the critically ill.

The costs of ICU are high and will undoubtedly get higher. Cost analyses of ICU therapy must be ongoing so that realistic strategies can be adopted to reduce the cost of an ICU admission without the sacrifice of quality care. The development of accurate and fair prepayment schedules for the ICU patient population in Canada should reflect the effects of not only diagnosis and length of stay, but also severity of illness, admission status, and outcome.

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Résumé

Une analyse prospective des coûts des soins intensifs est faite sur 67 admissions à l'unité multidisciplinaire des soins intensifs. Les admissions étaient groupées et investiguées selon des critères variés tels que le diagnostic d'admission, l'état à l'admission (électif vs urgence), la sévérité de la maladie et le résultat final. Le coût total de l'admission, le coût total per diem aux soins intensifs et le coût per diem séparé en coût des items fixes et variables pour les groupes de patients est rapporté. Des coûts plus bas, totaux et per diem ont été notés pour des patients chirurgicaux admis électivement, des patients présentant des maladies moins sévères telles qu'évaluées par le système du "Therapeutic Intervention Scoring System and Survivors". Les admissions d'urgence étaient plus coûteuses que les admissions électives quand on compare le coût total de l'admission aux soins intensifs. La durée du séjour était un facteur significatif dans le coût total des soins intensifs. Dans les items variables, le coût des tests diagnostiques de laboratoire était l'item le plus coûteux par jour. Comme résultat de cette anlyse les auteurs proposent plusieurs suggestions pour réduire le coût des soins intensifs indépendamment de la présence des cas mixtes ou du groupement des patients en fonction du diagnostic.