



Original Article

Economic burden of routine hematologic tests and intensive care unit observation for elective anterior cervical discectomy and fusion

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Abstract

Background: Anterior cervical discectomy and fusion is one of the most common surgical interventions performed by spine surgeons. As efforts are made to control healthcare spending because of the limited or capped resources offered by the National Health Insurance, surgeons are faced with the challenge of offering high-level patient care while minimizing associated healthcare expenditures. Routine ordering of postoperative hematologic tests and observational intensive care unit (ICU) stay might be areas of potential cost containment. This study was designed to determine the necessity of routine postoperative hematologic tests and ICU stay for patients undergoing elective anterior cervical discectomy and fusion and to investigate whether the elimination of unnecessary postoperative laboratory blood studies and ICU stay inhibits patient care.

Methods: The necessity for postoperative blood tests was determined if there were needs for a postoperative blood transfusion and hospital readmission within 1 month after surgery. The necessity for postoperative ICU observation was decided if immediate surgical intervention was required when any kind of complications occurred during the ICU stay.

Results: There were 168 patients collected in the study. Among them, all had routine preoperative and postoperative blood tests and were transferred to ICU for observation. No need for blood transfusion was observed, and no patient required immediate surgical intervention when the complications occurred during the ICU stay.

Conclusion: Cost savings per admission amounted to approximately 10% of the hospitalization cost by the elimination of unnecessary postoperative routine laboratory blood studies and observational ICU stay without waiving patient care in the current volatile, cost-conscious healthcare environment in Taiwan.

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Keywords: anterior cervical discectomy and fusion; economic; elective; hematologic; intensive care unit; routine

1. Introduction

Anterior cervical discectomy and fusion (ACDF) is one of the most common surgical interventions performed by spine

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surgeons for degenerative cervical spondylosis (DCS).^{1–4} The increasing number of ACDF procedures performed annually is believed to be attributed to the decreased length of hospital stays, decreases in complications, the provision of symptom relief and, more importantly, the improvement of quality of life.^{3,5} As efforts are made to control healthcare spending because of the limited or capped resources offered by the National Health Insurance (NHI), surgeons are faced with the challenge of offering high-level patient care while minimizing associated healthcare expenditures.^{3,4}

To maximize cost savings, Western spine surgeons have tried to change ACDF from a principally inpatient to an outpatient procedure.^{6–10} However, the extensive adoption of this procedure as a standard of care has not occurred because different risks—complications such as intraoperative vascular injury, postoperative dysphagia, soft-tissue swelling, wound hematoma, esophageal or pharyngeal perforation, hardware failure, and nerve damage—must be taken into consideration.^{11–14} Therefore, at most hospitals, ACDF remains an inpatient procedure with an average stay of 2–8 days.^{4,5}

Routine ordering of postoperative hematologic tests³ and postoperative observational stay in the intensive care unit (ICU) might be areas of potential cost containment. Vital signs, physical examination, and these blood studies are key determinants for surgeons deciding whether a patient needs a blood transfusion. Routine transfer of a patient into ICU after ACDF is also a part of a standardized postoperative order set at our neuroscience center to ensure prompt intervention is offered if complications occur. However, these blood tests and observational stay in the ICU have only become parts of a standardized postoperative order set and are ordered without regard for necessity or specific patient- or surgery-related factors.

In this study, the focus was to determine the necessity of routine postoperative hematologic tests and observational stay in the ICU for patients undergoing ACDF for DCS, i.e., to investigate whether the elimination of unnecessary postoperative laboratory blood studies and ICU stay for observation inhibits patient care.

2. Methods

After Institutional Review Board approval was obtained, the authors reviewed retrospectively the patient database of the Neuroscience Center of Kaohsiung Medical University Hospital and identified 266 consecutive patients with DCS who underwent ACDF for single- to multi-level diseases by neurosurgeons from January 2009 to December 2011 at their medical center (Fig. 1). Polyetheretherketone intervertebral cages and Bryan discs were used as fusion material. Patients were excluded based on C1-2 involvement, trauma, neoplasia, or previous cervical fusion/operation.

By reviewing the complete medical records, which consisted of operative notes, discharge notes, laboratory data, demographic and clinical data—including patient age, sex, number of levels involved, complications, pre- and

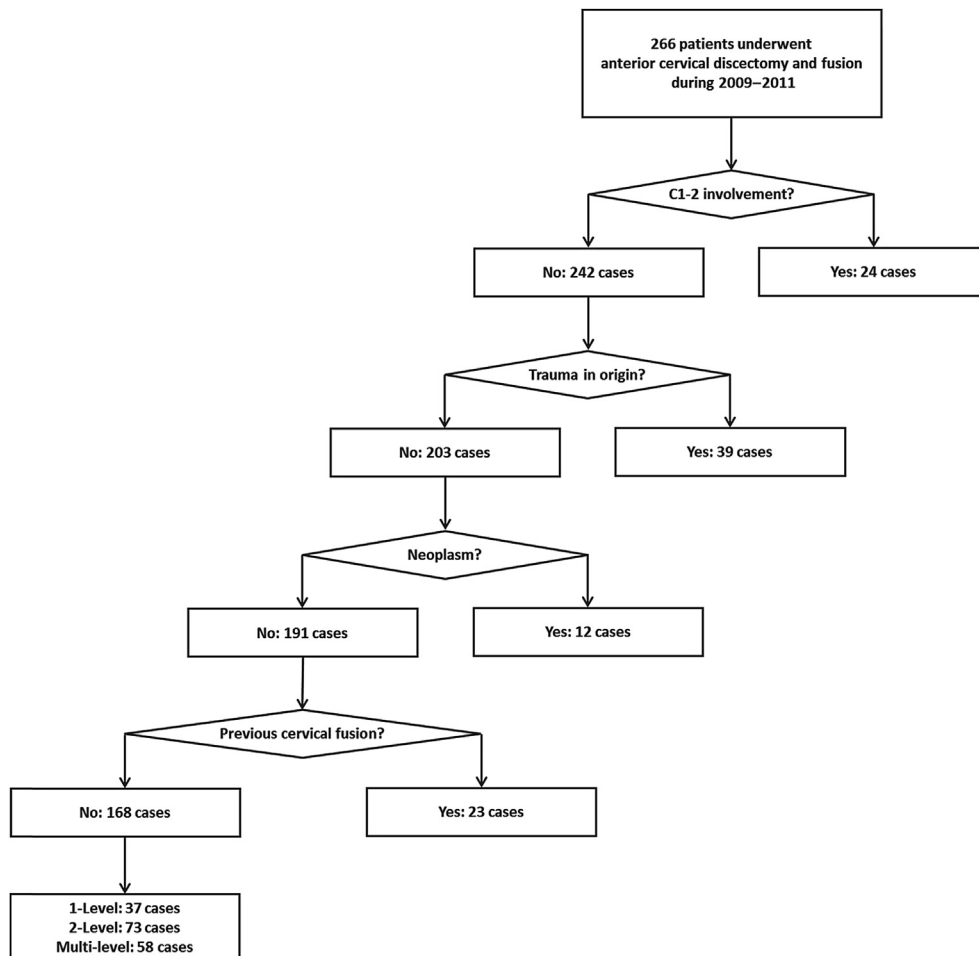


Fig. 1. Patient selection chart.

postoperative hematologic studies (liver function, renal function, complete blood count, coagulation studies, and type), estimated blood loss, postoperative transfusion, length of hospital stay, length of ICU stay, hospitalization cost, and incidence of hospital readmissions within 1 month after surgery for complications—were collected. Cost data were estimated by using hospital inpatient reimbursement (NHI) data. Data were analyzed using Student *t* test, one-way analysis of variance or Pearson χ^2 test as appropriate. The necessity for postoperative blood tests was determined if there was need for a postoperative blood transfusion and/or hospital readmission within 1 month after surgery. The necessity for postoperative ICU observation was decided if immediate surgical intervention was required when any kind of complications occurred during the ICU stay. A *p* value of <0.05 was considered statistically significant. Statistical analyses for the study were performed using SPSS version 12.0 for Windows (SPSS Inc., Chicago, IL, USA).

3. Results

Of 266 patients screened, 168 (80 men and 88 women) met the inclusion criteria. All patients had one preoperative test of biochemistry, complete blood count, coagulation, and type and one postoperative test of biochemistry and complete blood count. All patients were planned to be transferred to ICU for postoperative observation. Table 1 shows that their average age was 54.89 years (range, 21–85 years), average estimated blood loss was 63.27 mL (median, 30 mL; range, 5–355 mL), average length of hospital stay was 8.55 days (range, 4–39 days), average length of ICU stay was 1.20 days (range, 0–3 days), and the average hospitalization cost was US\$3325.43 ± 901.64 (range, US\$747.93–5965.38; currency

exchange of US\$ to NT\$ is 1/30.12). Postoperative complications occurred in 24.4% of the patients (Tables 1 and 2). They were generally mild postoperative nausea, vomiting, and dizziness without the need for intensive care. Furthermore, no complication required immediate surgical intervention. There were no hematomas, airway complications, or deaths.

The study population was further divided into three groups: those who underwent one-level ACDF; those who underwent two-level ACDF; and those who underwent ≥3-level (multi-level) ACDF. No significant differences were found between groups in terms of sex, length of hospital stay, or length of ICU stay (Table 3). Patients undergoing multi-level ACDF were significantly older than those who underwent two-level and one-level ACDF (*p* = 0.01 and *p* < 0.001, respectively). In addition, the multi-level group had significantly greater estimated blood loss (comparing multi-level vs. two- and one-level, *p* = 0.02 and *p* = 0.01, respectively). Incidence of complications was significantly associated with levels of the disease (*p* = 0.02). No subsequent need for blood tests or transfusion was observed when the complications occurred in the study population. No patient required immediate surgical intervention when the complications occurred during the ICU stay. In addition, no patient required hospital readmission within 1 month after surgery for complications.

4. Discussion

Effort to reduce medical costs is always demanded as healthcare reform continues to change the landscape of single-payer medical reimbursement system here in Taiwan. All in all, a balance between such decreases in healthcare costs and the quality of patient care must be found. Because most medical care costs in ACDF are derived from the implants used and these costs are typically fixed, the potential decreases in costs will only be found in changes to the pre- and post-surgical aspects of routine patient care.

Laboratory blood tests after surgical interventions are routine and common. However, these studies frequently become part of a postoperative care protocol with little regard for patient-specific or surgery-related characteristics. In addition, the necessity of the studies for all surgical cases has never been proven.³ Acute postoperative anemia is one of the most common reasons for postoperative blood tests, e.g., complete blood count. However, postoperative anemia has never been previously reported as a common complication in ACDF. In

Table 1
Patient demographics (*n* = 168).

Age, y	54.89 ± 12.30 (21–85)
Sex, F/M (%)	88 (52.4)/80 (47.6)
BMI	24.51 ± 4.03 (15.40–38.72)
CCI	
0	78 (46.4)
≥1	90 (53.6)
ASA status	
II	142 (84.5)
III	26 (15.5)
Level of ACDF	
1-level	37 (22.0)
2-level	73 (43.5)
Multi-level ^a	58 (34.5)
Estimated blood loss, mL	63.27 ± 74.34 (5–355)
Complication	41 (24.4)
Length of hospital stay, d	8.55 ± 4.41 (4–39)
Length of ICU stay, d	1.20 ± 0.50 (0–3)
Hospitalization cost, US\$	3325.43 ± 901.64 (747.93–5965.38)

Data are presented as *n* (%) or mean ± SD (range).

ACDF = Anterior cervical discectomy and fusion; ASA = American Society of Anesthesiologists BMI = body mass index; CCI = Charlson comorbidity index; ICU = intensive care unit.

^a Multilevel = ≥three levels.

Table 2
Complications and their relevance.

Complications	41 (24.4)	Related
Agitation	3 (1.8)	Anesthesia
PONV	17 (10.1)	Anesthesia
Mild sore throat	18 (10.7)	Anesthesia
Mild dizziness	3 (1.8)	Anesthesia
Wound hematoma	0	Surgery
Airway compression	0	Surgery

Data are presented as *n* (%).

PONV = postoperative nausea and vomiting.

Table 3
Comparison by levels of anterior cervical discectomy and fusion.

	1 level (n = 37)	2 levels (n = 73)	Multilevel (n = 58)	p
Age, y	50.41 ± 14.27	53.79 ± 11.12	59.60 ± 10.70	<0.001
No. female	23 (62.2)	38 (52.1)	27 (45.6)	0.36 ^a
Complication	15 (36.6)	17 (41.5)	9 (22.0)	0.02 ^a
Estimated blood loss, mL	30.95 ± 28.18	59.52 ± 73.72	94.47 ± 118.54	<0.001
Length of hospital stay, d	7.65 ± 3.97	8.53 ± 5.03	9.18 ± 3.79	0.26
Length of ICU stay, d	1.24 ± 0.55	1.16 ± 0.47	1.23 ± 0.50	0.66

Data are presented as n (%) or mean ± SD.

ICU = intensive care unit; LSD = Fisher's least significant difference.

^a Number of female patients and complications between all groups were tested by χ^2 test, others were compared by one-way analysis of variance. (Post hoc test: LSD).

the present study, no patient required a blood transfusion because intraoperative blood loss was scant. The overall average estimated intraoperative blood loss was 63.27 mL (range, 5–355 mL) with a median of 30 mL. Significantly older age and greater estimated blood loss were found in patients undergoing multi-level ACDF procedures when compared with both two-level and one-level procedures. These findings are not surprising because of the age-related pathogenesis and the increased complexity of the multilevel cases. However, the average estimated blood loss was still < 100 mL in patients undergoing multilevel ACDF procedures. The true value of postoperative blood tests seems then limited to the early identification of postoperative anemia that they offer, which allows for prime resuscitation, reduces the risk for secondary complications, and helps to speed healing and overall recovery. Obviously, the necessity of postoperative routine blood tests should be evaluated prudently.

Common complications associated with ACDF include intraoperative vascular injury, postoperative dysphagia, soft-tissue swelling, wound hematoma, esophageal or pharyngeal perforation, recurrent laryngeal nerve palsy, worsening myelopathy, hardware failure, and nerve damage.^{11–14} Delayed bleeding is a rare complication of ACDF, which is found at least 9 days after surgery and after patients are discharged.¹⁵ Postoperative blood studies would not be likely to reveal these vascular complications in the acute postoperative setting. Postoperative observational stay in the ICU would not reveal these vascular complications in the acute postoperative setting, either. However, surgeons must always be cautious of possible vascular injury and therefore monitor vital signs in addition to patient-specific objectives on the general wards.

The findings in this study are broadly consistent with those of previously published studies in other fields of medicine focusing on the necessity of routine postoperative blood tests, which recommend that postoperative blood tests should be limited to those patients who have had previous hematologic issues, baseline anemia or identifiable risk factors and those with excessive intraoperative blood loss.^{16,17} Postoperative blood studies are also suggested to be streamlined to those measurements that might lead to therapeutic intervention.¹⁸ Our findings lend support to the suggestion that no postoperative blood test is to be routinely performed for patients undergoing ACDF procedures unless they have had a comorbidity of DM, coagulation disorders, and severe hepatic and/or

renal dysfunctions. However, studies related to the limitation of ICU use are lacking. Whether or not to routinely transfer a patient into ICU for observation after ACDF procedure is still controversial; some centers such as our neuroscience center do, but some do not. Our findings suggest that postoperative observational ICU stay is required for patients undergoing multilevel ACDF procedures for the improvement of cost savings. Further studies examining potential complications with the levels of disease should target patients in specific conditions.

According to the reimbursement guidelines provided by the Bureau of NHI, the average cost of routine biochemical tests (for liver and kidney function) is US\$4.32, the cost of routine biochemical tests plus complete blood count is US\$6.64, the cost of a coagulation panel is US\$4.98, the cost of a typing is US\$1, and the cost for ICU stay/day is US\$239.04 at the authors' institution. These costs are universally reimbursed to every medical center nationwide. The average length of hospital stay and ICU stay of the present study were 8.55 days and 1.20 days, respectively. However, no differences in the average length of hospital stay and ICU stay were found between groups, indicating these two parameters were not strongly impacted by the severity of the disease. On the basis of the authors' data, the costs for blood tests/admission totaled US\$19.26/patient, which included US\$6.64 for postoperative blood tests. No blood transfusion or any therapeutic intervention during ICU and hospital stay was noted in the study population, implying feasibility of saving the cost for postoperative observation in the ICU and hematologic laboratory studies, no matter the severity of the disease. Postoperative observation in the ICU and hematologic laboratory studies were thus decided to be "unnecessary" and their costs were eliminated as well. From the viewpoint of hospitalization, 1.2 days (average ICU stay) could be saved, indicating 14% of hospital stay is generally preserved. ICU admission is frequently denied because beds are not readily available and its provision of focused and aggressive medical intervention to critically ill patients is sometimes unplanned. It may be more effective to reserve these ICU beds for critically ill patients rather than for patients undergoing elective ACDF. Cost savings per admission by subtracting unnecessary postoperative management of laboratory blood studies and observational ICU stays amounted to US\$293.49/patient, i.e., approximately 10% of the hospitalization cost. If extrapolated to include the

total number of ACDF performed nationally, which was around 1500 patients, the total cost savings would be US\$440,232/year. Adjustment to the national data of the average length of both hospital and ICU stay should be done to describe precisely the national cost savings for patients receiving ACDF procedures.

Limitations of this study include a lack of prospective randomized design, the small sample size, limited cost-saving analyses, and limited sources obtained from a single department (neurosurgery) at our institution. A large, prospective randomized study is warranted to delineate further the necessity of postoperative hematologic laboratory studies and observation in the ICU in all patients undergoing ACDF. Studies on other neurosurgical procedures, such as posterior cervical surgery and lumbar spine decompression, are also warranted. Full cost-saving analyses would include the interpretation of direct and indirect costs, e.g., implant choice, anesthesia cost, operative time, hospital stay, impact of complications, and return to work. However, such analyses were outside the scope of this study. In addition, the current study focused on the need for immediate postoperative hematologic laboratory studies and observation in the ICU in a specific patient population: those who were without any intraoperative complications or previous history of hematologic issues. The generalizability or applicability of the study conclusions is therefore limited.

In conclusion, the present study exemplifies the authors' intention to assess definitively the necessity of postoperative hematologic laboratory studies and observation in the ICU in patients undergoing elective ACDF because these procedures are associated with low intraoperative blood loss and shorter hospital stays. It will be more effective to reserve these ICU beds for critically ill patients rather than for patients following elective ACDF. The elimination of unnecessary postoperative laboratory blood studies and ICU stay for observation for patients undergoing elective ACDF is a definite and feasible way to improve cost savings without waiving patient care in the current volatile, cost-conscious healthcare environment in Taiwan. The patient-specific objective and subjective measures and monitoring of vital signs on the general wards can still play key roles in sustaining patient care. By this approach, the cumulative savings to the healthcare system might be perceptible.

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