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## *Physical Abuse in Children : A Surgeon's Perspective*

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### *Abstract*

**Background:** Physical abuse in children is one category of child abuse which surgeons are usually consulted. Its prevalence is anticipated to be increased as a result of the more stressful society. The natures of the victims, the perpetrators, the injuries, the management and its outcomes are the crucial data for the handling of this complicated problem.

**Materials and Methods:** Retrospective data collection was carried out from the records of all children diagnosed with physical abuse, who were admitted to the Children's Hospital, Bangkok, during a recent ten-year period (1992-2001).

**Results:** Of the 12 intentionally injured children, all but one were younger than 5 years of age, and half were younger than 1 year of age. Two-thirds of these abuses occurred in the last 4 years. Ten abusers were males. Head injury, abdominal injury, fractures, skin and soft tissue injuries were seen in 5, 6, 7, and 11 patients respectively. Several of whom had multiple injuries. Seven patients required surgical intervention: two for head injury, and five for abdominal injury. One patient died from massive hemorrhage. Of the eleven who recovered; two were discharged home, but nine ended up in charitable institutions.

**Conclusion:** The victims of physical abuse were usually very young infants. Direct blows and beating were the mechanism of assault. Head and abdominal injuries were often severe and required surgery. Fractures were mostly multiple and thus were a good clue to the diagnosis. Long-term fate of these victims are miserable.

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Violence is the dark side of human nature. The stronger oppresses the weaker, women and children are thence always the victims. Intentional injury to children conducted by parents or by others, who are supposed to provide them with care, indicates the illness of a family. Maltreatment of children is traditionally categorized as physical abuse, sexual abuse, emotional abuse, and neglect. Usually, surgeons are consulted when the patients are physically injured. This communication reports our experience with physical abuse in children during the recent ten-year period in a surgeon's perspective.

### MATERIALS AND METHODS

The medical records of all children diagnosed with child abuse, admitted to the Children's Hospital, Bangkok, during a 10-year period (1992-2001) were reviewed. Sexual abuse, emotional abuse, and neglect cases were excluded from this study. Only the ones who sustained physical injuries were included.

Providers of care were multidisciplinary which included a pediatrician, a pediatric surgeon, a psychiatrist, and welfare workers. A complete radiographic skeletal survey was done in all infants in whom there was a suspicion of abuse. Age of the patients, sites of injuries and results of treatment were analyzed. Long-term fates of these children were anticipated.

### RESULTS

From 1992 through 2001, 32 children were admitted with the diagnosis of child abuse. Of these, twelve patients were physically abused, two-thirds of which occurred in the last 4 years (Figure 1). All but one were younger than 5 years of age, and 50 percent were younger than 1 year of age (Figure 2). Seven were males and five were females. History given primarily to the physicians was not correlated with the physical findings in 6 patients, while it was specified as beaten in the other six. Regarding the abusers; seven were fathers, two were stepfathers, one was grandmother, one was uncle, and one was unknown. This information was obtained either from an interview by a psychiatrist or from an interrogation by police officers. As for the referral persons; six were mothers, three were agents of non-governmental organizations (NGOs), one each was grandmother, teacher, and neighbor. All cases

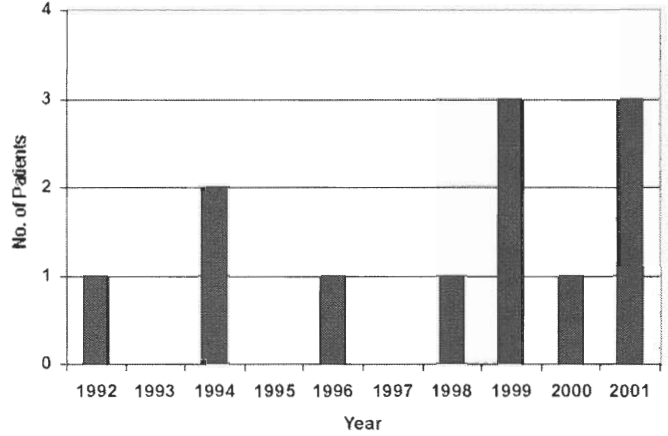


Fig. 1 Yearly distribution of the 12 physically abused children.

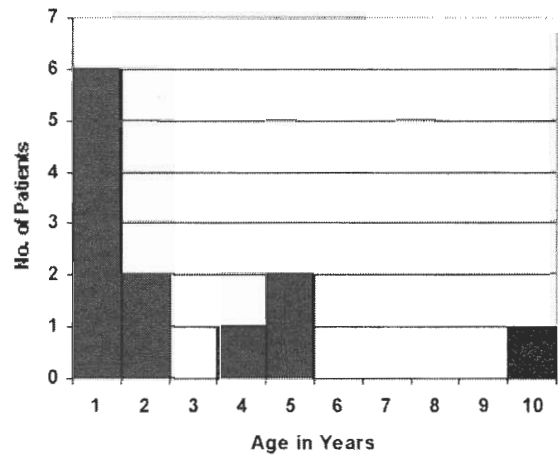


Fig. 2 Age distribution of the 12 physically abused children.

with NGOs involvement were sensationally reported in the media and intrigued certain politicians. Concerning the organs of involvement, it was categorized as head injury, abdominal injury, fractures, skin and soft tissue injuries.

#### Head injury

Five patients had head injury. All of them were very young infants, and had bruises on their heads and faces, indicating direct blows as the mechanism. Details of the injuries to the skull, to the brain and their treatments are shown in Table 1. Four patients also sustained rib and/or long-bone fractures. Data of fundoscopic findings were not available.

#### Abdominal injury

Six patients had injuries to the abdominal viscera.

**Table 1** Head injury in 5 patients

No.	Age	Skull	Brain	Treatment
1	1 month	Blowing fracture, left parietal bone	Contusion Subarachnoid hemorrhage Epidural hematoma	Conservative
2*	1 month	No fracture	Diffuse edema Subdural hematoma	Subdural tap
3*	2 months	Fracture, left parietal bone	Subdural hematoma	Burr holes and irrigation
4*	4 months	Fracture, right parietal bone	Subdural hematoma	Conservative
5*	1+ year	No fracture	Subdural hemorrhage (interhemispheric fissure)	Conservative

\*Also had rib fractures and/or long-bone fractures

**Table 2** Abdominal injury in 6 patients

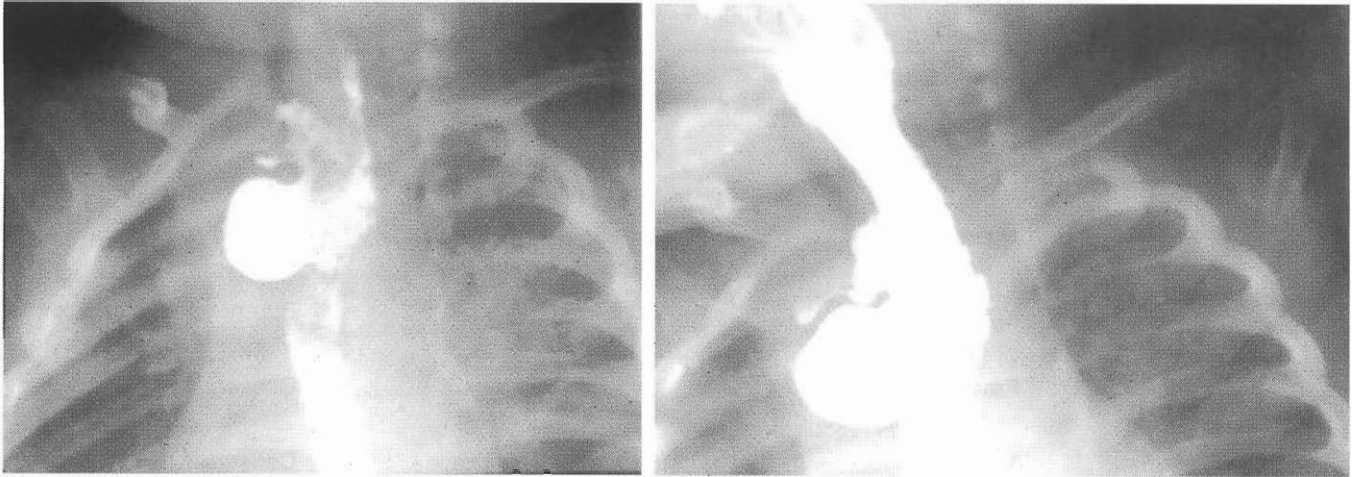
No.	Age	Injuries	Treatment
1*	11 months	Hemoperitoneum 150 ml Laceration of mesentery, gangrene of right colon Laceration of pancreas	Right half colectomy Repair of pancreas
2	1+ year	Necrosis around pancreas	Debridement Drainage Gastrostomy (Operated elsewhere)
3*	5 years	Intramural hematoma of duodenum	Conservative
4*	1+ year	Rupture of bladder	Repair of bladder Cystostomy
5*	3 months	Leak of esophagus	Esophagoscopy Gastrostomy
6	4+ years	Hemoperitoneum 1,000 ml Avulsion of hepatic veins and inferior vena cava	Repair of vena cava

\*Also had rib fractures and / or long-bone fractures

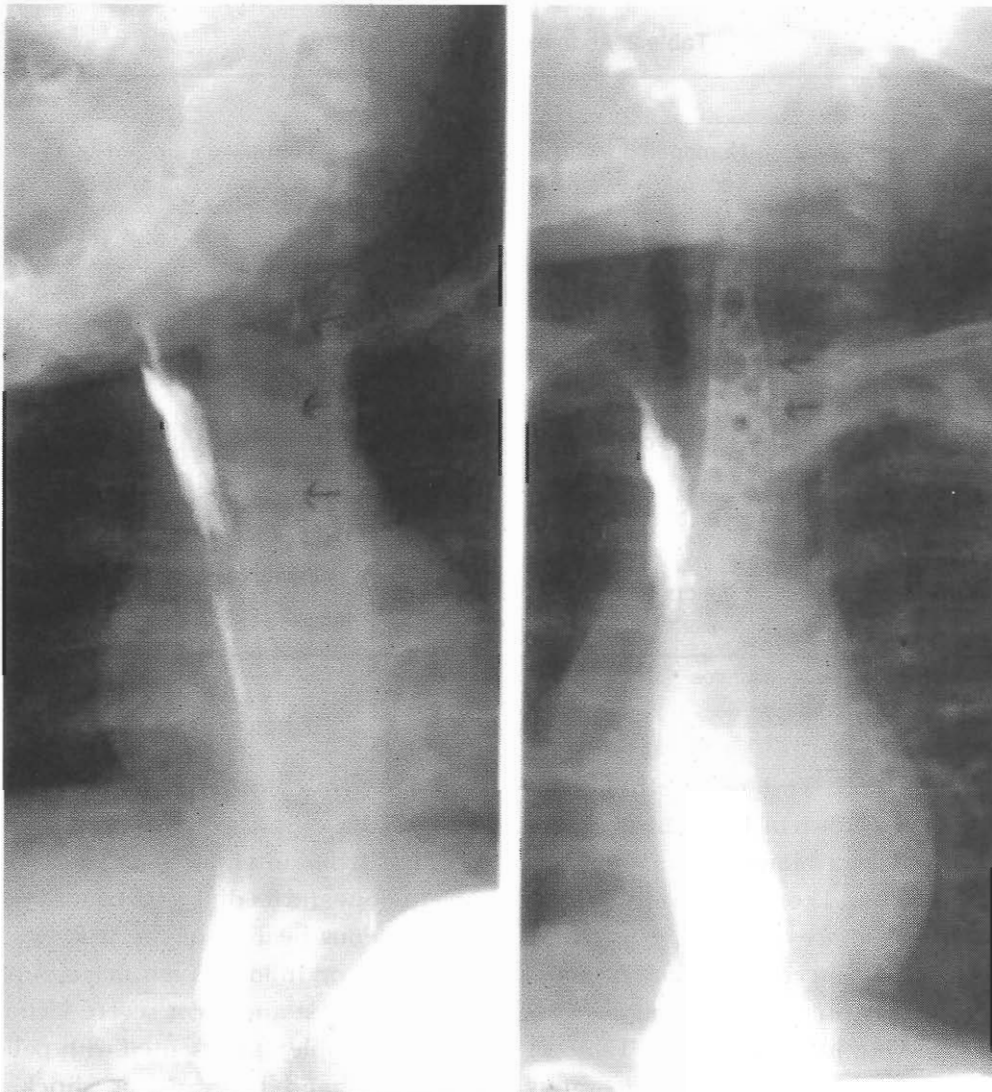
Most of these were severe and required surgical intervention. Details are shown in Table 2. All except one were inflicted by direct blows to the abdomen. Four patients also had rib and /or long-bone fractures. Three had bruises on their faces or trunk. One (No. 1 in Table 2) had generalized incense-stick burn wounds at various stages of healing previously misdiagnosed as Pemphigus vulgaris. One infant (No. 5 in Table 2) presented with choking upon feeding. Esophagography revealed a leak of the esophagus forming a false tract without mediastinitis (Figure 3). She also had rib and

long-bone fractures at different stages of healing. The leak of the esophagus hence was presumed to be resulted from intentional corrosive feeding. Esophagoscopy and feeding gastrostomy were performed. Spontaneous healing of the leak was expected and confirmed on follow-up esophagography (Figure 4).

The latest and most severe victim in this study (No. 6 in Table 2) presented with pallor, abdominal distention, and hypovolemic shock. Laparotomy revealed avulsion of the hepatic veins and the inferior vena cava with massive hemorrhage. Repair of the vena



**Fig. 3** Esophagography : leak of the esophagus forming a false tract.



**Fig. 4** Esophagography : same patient as in Figure 3, three months later. Note the healing of the leak and resolution of the false tract.

cava was not successful and the patient died during surgery . This was the only mortality in the series.

**Fractures**

Apart from skull fractures which is shown under the heading of Head injury, seven patients had skeletal fractures (Table 3). All rib fractures were multiple and at various stages of healing (Figure 5). Long-bone fractures had no specific pattern or characteristic. One

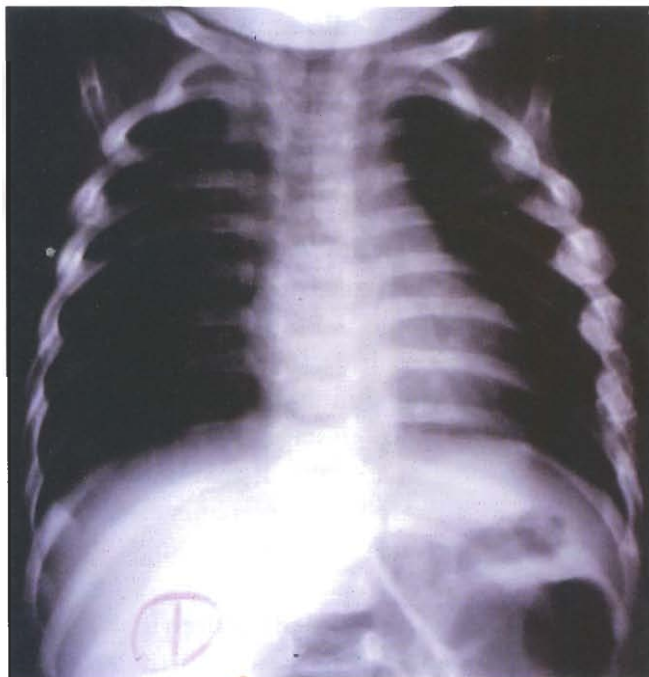
infant (No. 5 in Table 3) had fracture of the superior pubic ramus and rupture of the bladder.

**Skin and soft tissue injuries**

Eleven patients sustained skin and soft tissue injuries: involving the head and face in ten, the whole body in four, and the extremities in five. Regarding types of the lesions; nine had bruises, one had generalized incense-stick burn wounds, one had an iron burn, and one had multiple scars over the extremities. Skin and soft tissue injuries provided the most readily discernible lesions on physical examination

**Table 3** Fractures, excluding skull fractures, in 7 patients

No.	Age	Ribs	Long Bones and Others
1	1 month	Multiple Clavicles, both	Femurs, Tibias, Fibulas
2	11 months	Multiple	-
3	2 months	Multiple Clavicle, left	-
4	5 years	-	Humerus, right Metacarpal, left
5	1+ year	Multiple	Superior pubic ramus
6	3 months	Multiple	Femur, left
7	4 months	-	Humerus, left



**Fig. 5** Chest film : multiple rib fractures at different stages of healing.



**Fig. 6** Bruises on the face and body.





**Fig. 7** Burn wound at left forearm, clearly identifiable as inflicted by an iron.



**Fig. 8** Lip ulcers caused by application of rubber glue.

(Figure 6). Burns from a solid source had identifiable characteristics (Figure 7). Lip ulcers caused by rubber glue, applied to silence the child, were also remarkable (Figure 8).

### *Treatment and outcomes*

Seven patients required surgical intervention: two for head injury (Table 1), and five for abdominal injury (Table 2). All fractures were treated conservatively. Skin and soft tissue injuries also healed expectantly. One patient, who had avulsion of the hepatic veins and the inferior vena cava, died from massive hemorrhage. The other eleven patients recovered, two were discharged home, but nine ended up in charitable institutions.

## DISCUSSION

Cruelty to children, afflicted by their parents, has been recognized since old time. In certain communities, infanticide was not uncommon nor sporadic but scarily systematic.<sup>1</sup> The idea that children possess a "right" to reasonable treatment from their parents was established in the late nineteenth century. Private philanthropist, not the medical profession, directed the campaign against child abuse.<sup>1</sup> Unfortunately, public interest in this issue had declined since 1910s, as a result of the two world wars and protracted economic crisis.<sup>1</sup> Medical profession dates the "discovery" of child abuse from the mid-1950s, when American radiologists noted a connection between skeletal lesions in infants and parental maltreatment.<sup>2,3</sup> However, widespread medical concern about the abuse of the young did not materialize until Kempe et al, in 1962, published the landmark article on the battered child syndrome.<sup>4</sup> Ten years later, Caffey described the shaken baby syndrome.<sup>5</sup> Both syndromes are now recognized by the medical and legal professions. The victims usually exhibit multiple injuries, including fractures, bruises at various stages of healing, lesions in the shape of an identifiable object, subdural hematoma, and failure to thrive. The discrepancy between the history of the injury and the physical findings is cardinal to the suspicion of child abuse.

The majority of the abused children in this review were very young since they were at the irritable end of the normal spectrum, demanding, and difficult to manage. Ten abusers (83%) were males, a pheno-

menon as observed in other mammals. Rise in the prevalence since 1998 may be related to the stress from the 1997 economic crisis in this country, in addition to the more awareness of the occurrence of child abuse.

Severe accidental head trauma is uncommon in children younger than 2 years of age, and most cases of serious intracranial injuries in infants are the result of abuse.<sup>6</sup> Subdural hematoma is significant as its concomitant brain injury often leads to death or serious long-term disability. Household accidental subdural hematoma is very unlikely, and in the presence of concurrent rib or long-bone fractures, with no plausible explanation, strongly suggests an intentional injury. Infants with shaken baby syndrome manifest symptoms and signs of increased intracranial pressure resulted from cerebral edema without skull fracture and external soft tissue trauma.<sup>5</sup> Retinal hemorrhages are often present and are considered specific.<sup>7</sup> In our patients with head injury, all had bruises on their heads and faces indicating direct blows as the mechanism. No one fitted in with shaken baby syndrome. Thus it was presumed that shaking the baby was not, but beating was, the assault act of the perpetrators.

Abdominal injury in abused children tends to be severe and delayed in seeking treatment.<sup>8,9</sup> Unlike inflicted head and skeletal trauma, abdominal injuries are found predominantly in children older than 2 years of age.<sup>9,10</sup> However, in our series, young infants were not spared and even predominated. The mid-abdomen is especially vulnerable to direct blows causing compression injuries to the anatomically fixed viscera; namely the duodenum, mesentery, and the pancreas, against the spine.<sup>10-14</sup> Intramural hematomas of the duodenum and intestine are more common than intestinal perforation.<sup>15</sup> Pancreatic trauma is the most common cause of acute pancreatitis and pancreatic pseudocyst in children,<sup>16-18</sup> and one third of these are related to abuse.<sup>16</sup> Injuries to the liver, spleen, and worst of all, the great vessels, can result in massive hemorrhage and death.<sup>9</sup> Inflicted esophageal perforations had been reported sporadically, most of which were injured by foreign bodies, or caustic agents.<sup>19</sup>

More than half of our patients had fractures. Skeletal fracture is the most common radiologic finding accounting for 80 per cent of all abuse-related injuries identified by radiologic imaging.<sup>15</sup> A complete radiographic skeletal survey hence should be done in all infants in whom there is a suspicion of abuse. Long-

bone fractures are the most common inflicted skeletal injury.<sup>15</sup> They can be spiral or transverse, depending on the assaulting force. Metaphyseal-epiphyseal injuries are less frequent, but are considered highly specific to nonaccidental injury, since the forces necessary to produce such fractures can hardly be generated from simple accidents.<sup>20-22</sup> Rib fractures have been reported in 5-27 per cent of abused children.<sup>13</sup> In infants, the rib cage is relatively compliant and rarely breaks. Thus, in the absence of major trauma, rib fractures in infants, especially if multiple, must be considered evidence of nonaccidental injury.

Skin and soft tissue injuries are overt and easily detected. Bruises are the most common lesion. Two black eyes are strongly suggestive of abuse.<sup>23</sup> Cigarette or incense-stick burn wounds may be misleading, but burns from a solid source have identifiable patterns. All but one patient in our series had skin and soft tissue injuries indicating that direct beating was the perpetrators' choice. The magnitude and extent of these injuries usually lead to suspicion of abuse.

Surgical treatment is rather straightforward as directed by the injury. However, it solves only the iceberg tip of a much more vicious and sophisticated social problem. The management is further complicated when it involves the NGOs, the media, and the politicians. Each of whom serves one's own interest but not the child's. Long-term fate of these victims are miserable regardless of whereabouts they end up in, either home or charitable institution.

Most abuse occurs in families so prevention should be targeted there. Unfortunately, parental unpreparedness and irresponsibility hardly make such effort fruitful. Child abuse is often repeated in a family and often transmitted from one generation to the next. The outlook on its solution is painfully dim.

In conclusion, if only surgery is concerned, the lessons learned from this review are: (1) the victims of physical abuse were usually very young infants, (2) direct blows and beating were the mechanism of assault, (3) head and abdominal injuries were often severe and required surgery, and (4) fractures were mostly multiple and thus were a good clue to the diagnosis.

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# *Phlegmasia Caerulea Dolens and Venous Gangrene*

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## **Abstract**

**Objectives:** Phlegmasia caerulea dolens (PCD) and venous gangrene are rare conditions of severe form of lower extremity acute deep vein thrombosis (DVT) that trend to occur in association with malignancy and hypercoagulable state. Our aim is to evaluate the results of surgical management in 15 patients with PCD and venous gangrene in 125 DVT patients.

**Methods:** This is a 12 year (140 months) retrospective study in management of 6 PCD and 9 venous gangrene patients from total 125 patients with acute DVT of lower extremities seen at Chiang Mai University Hospital and nearby private hospitals from January 1991 to August 2002.

**Results:** Six patient with impending gangrene and failure from initial management of bed rest, extremity elevation, fluid resuscitation and systemic anticoagulation for 6-12 hours underwent iliofemoral venous thrombectomy and distal arteriovenous fistula. All of these patients achieved limb salvage. In other nine patients with venous gangrene underwent iliofemoral thrombectomy, 2 caval interruption, inevitable below knee and transmetatarsal amputation was performed after improved leg oedema. There was no pulmonary embolism (PE) or immediated mortality.

**Conclusion:** Venous thrombectomy with temporary distal arteriovenous fistula are indicated for treatment of PCD after failure of anticoagulation or impending venous gangrene. In patients with venous gangrene, thrombectomy can decreased oedema, limited extension of gangrene with preservation the length of leg amputation and reduced the rate of pulmonary embolism.

Venous thrombectomy should be reserved for patients with contraindications to thrombolysis or in condition that thrombolytic therapy is not available.

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Phlegmasia caerulea dolens (PCD) is an acute severe and extensive iliofemoral deep vein thrombosis (DVT) that causes massive thrombotic occlusion of the venous drainage of the extremity. It also involves microvascular collaterals with extension of thrombosis to venular and capillary levels. PCD is characterized by cyanosis in an acutely swollen limb with an extreme constant bursting pain, a potentially reversible phase of ischaemic venous occlusion that may progress to venous gangrene in 40-60 percent of cases.<sup>1</sup> Venous gangrene is always preceded by phlegmasia caerulea dolens starting distally in the toes and foot which progresses proximally and may involve skin and

subcutaneous tissue, or muscle or both. At the tissue level, venous thrombosis produces a massive increase in capillary hydrostatic pressure causing outpouring of fluid and massive interstitial oedema. Such pressure in the tissues may increase up to five folds.<sup>2-4</sup> A significant percentage of PCD may require extremity amputation and the mortality rate has been reported in the range of 25-41 per cent.<sup>5</sup> Pulmonary embolism (PE) is common in venous gangrene with an incidence of 12-40 per cent.<sup>6</sup>

Therapeutic options for PCD include anticoagulation, fasciotomy, venous thrombectomy and thrombolysis.<sup>1,6-8</sup> Treatment in an early uncomplicated

cases consists of intravenous fluid resuscitation to correct hypovolemic shock, bed rest, extremity elevation and heparin therapy.<sup>1,6</sup> Failure of clinical response within 6-12 hours should be followed by iliofemoral venous thrombectomy or thrombolysis.<sup>1,6,9</sup> For patients presenting with severe ischaemia or impending venous gangrene, venous thrombectomy has been recommended as the primary intervention.<sup>8,10-12</sup>

In this report we described our experience using this treatment algorithm and thrombectomy in 15 advanced cases of PCD and venous gangrene out of the total of 125 patients of acute deep vein thrombosis seen in consultation at University and private hospitals during a period of 140 months from January 1991 through August 2002.

### PATIENTS AND METHODS

From January 1991 through August 2002, fifteen patients (19 extremities) with PCD and venous

**Table 1** Number of the patients with DVT venous gangrene and PCD seen during 1991-2002 (140 months period).

	1991-1995	1996-1999	2000-2002	Total
DVT	30	38	42	112
Venous gangrene	2	3	4	9
PCD	1	1	4	6
	<b>33</b>	<b>42</b>	<b>50</b>	<b>125</b>

**Table 2** Sex, Side involved and associated condition in 15 patients with PCD and venous gangrene

Patient Data	1991-1999	2000-2002	Total
<b>Sex</b>			
Men	2	2	4
Women	5	6	11
<b>Side involved</b>			
Right side	2	1	3
Left side	4	4	8
Both sides	1	3	4
<b>Associated conditions</b>			
Hyper coagulable state	7	8	15
The regimen of malignancies	6	3	9
Prolonged bed rest	5	4	9
Previous DVT	3	3	6
Diabetes	2	1	3

Average age 56 (38-81) years

gangrene were evaluated. Eleven patients were women and 4 men. Their mean age was 56 years with a range of 38-81 years. (Tables 1, 2) (Figure 1).

Associated conditions known to predispose to thrombotic events were present in all 15 patients. Malignancy was the most common condition. There were nine cases with history of malignancy. Documented primary sites included lung (3), ovary (2), cervix (2), and pancreas (2). A prior history of lower extremity deep vein thrombosis was elicited in six patients. Nine patients had prolonged bed rest (over one month) from the illness prior to the development of PCD. Diabetes mellitus was present in three patients. Other associated conditions were COPD, renal failure, pneumonitis, gastroenteritis, atrial fibrillation and coronary heart disease. More than one associated conditions was presented in all 15 patients. All of the patients were in hypercoagulable state (Table 3).

All patients had pain, massive oedema, and cyanosis of the affected extremity at the time of initial evaluation (Figure 1). Disease was present bilaterally



**Fig. 1** PCD with mottling cyanosis and severe pain on the left foot in a 38 year-old women patient.



**Fig. 2** Venous gangrene with cutaneous blebs on the left foot



**Fig. 3** Bilateral venous gangrene of feet with cutaneous blebs

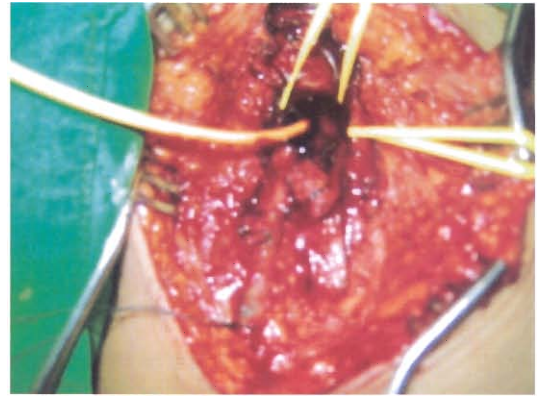


**Fig. 4** Ultrasound examination on right groin demonstrating uncompressible intraluminal thrombus of the femoral vein.



**Fig. 5** Venous collaterals around an extensive iliofemoral thrombosis

in four patients. Venous gangrene was present at the initial evaluation in nine patients (12 extremities). (Figures 2, 3). Pedal pulse deficit was found in 12 patients. There were 12 left sided and 7 right-sided thrombosis. The mean duration of symptoms was 6 days (range 1-12 days).



**Fig. 6** Venous thrombectomy and distal arteriovenous fistular.  
(A) Longitudinal incision on common femoral vein for iliofemoral venous thrombectomy.  
(B) Creation of distal arteriovenous fistula with end side branch of greater saphenous vein to side superficial femoral artery after closure of common femoral venotomy.

A presumptive diagnosis of PCD and venous gangrene was made on clinical presentation and confirmed by Doppler venous examination in 19 ultrasonography in 7, venous color-flow duplex scan in 8, and phlebography in 2 extremities. Abdominal CT scan revealed extensive involvement of iliac vein thrombosis in 2 patients (Figures 4, 5).

Two patients with severe pain and cyanosis who were diagnosed at bedside with Doppler examination and ultrasonography underwent immediate iliofemoral venous thrombectomy after an initial intravenous bolus of 5,000 units of heparin.

All others 13 patients were initially managed with bed rest, extremity elevation, fluid resuscitation and systemic anticoagulation. The regimen of anticoagulation included an initial intravenous bolus of 5,000 units of heparin, followed by a continuous infusion to maintain the activated partial thrombo-



plastin time (a PTT) at least to the twice the control value. Four patients, with impending venous gangrene who failed to respond to initial anticoagulation in 6-12 hours, underwent emergency iliofemoral venous thrombectomy. Nine patients presenting with venous gangrene underwent venous thrombectomy after initial therapeutic maneuver. Iliofemoral venous thrombectomy was done in all patients (19 extremities) of whom eleven with distal arterio-venous fistula (Figures 6, 7). Caval interruption was performed in 2 patients due to extensive IVC and iliac veins thrombosis detected by abdominal CT scan. Vascular scope or

pediatric bronchoscope was used intraoperatively to evaluate the residual thrombus. Calf and thigh fasciotomy was done in 12 extremities (7 patients) due to massive oedema and elevated compartment pressure (Table 3). In 9 patients with venous gangrene, amputation was done in 12 extremities with 7 transmetatarsally and 5 below knee. Heparin therapy was continued for 10 days thereafter a long term oral anticoagulation therapy was continued for 3-6 months. All 6 patients with impending gangrene and failure to initial therapeutic maneuver who underwent venous thrombectomy survived with limb salvage.

## RESULTS

The rate of PCD in DVT of our patients during 1991-2002 was 12 percent (15 of 125) and progression to venous gangrene was 60 percent (9 of 15).

After iliofemoral venous thrombectomy the patients experienced less pain and decreased leg oedema. For the 9 venous gangrene patients, 5 underwent (7 extremities) transmetatarsal amputation, 4 patients (5 extremities) underwent inevitable below-knee amputation because the extent of venous gangrene had involved skin, subcutaneous tissue down to muscle compartments or following inadequate previous transmetatarsal amputations (Table 3). There was no immediate mortality. The distal arteriovenous fistula was closed as secondary operation 3 months after the initial operation.

The mean follow up period was 42 months (3-80 months). Seven patients died from advanced carcinoma at 3, 7, 9, 12 and 14 months after the vascular operation. The remaining 6 patients were followed up every 1-12 months. Four patients lost follow up 1 to 5 years later. Two patients (one with COPD and the other with post operative coronary artery bypass graft) have been followed up beyond 60 months without sign and symptom of post phlebotic syndrome (PPS).

## DISCUSSIONS

Treatment of PCD is aimed at preventing propagation of thrombus and reducing venous hypertension to preserve tissue viability.<sup>1,7,8</sup> Initial management are the correction of hypotension by intravenous fluid resuscitation, bed rest and leg elevation.<sup>1,6</sup>



**Fig. 7** (A) Fresh thrombus from the patient in Figure 1 who underwent immediate venous thrombectomy  
(B) Organized thrombus from venous gangrene patient who came on 12th day after DVT.

**Table 3** Surgical treatment of PCD and venous gangrene

	1991-1999	2000-2002	Total
Venous thrombectomy	8	11	19
Distal arteriovenous fistula (4 patients had bilateral iliofemoral venous thrombosis)	4	7	11
Fasciotomies	5	7	12
Amputations	6	6	12
- transmetatarsals	4	3	7
- below - knee	2	3	5
Caval interruption	2	-	2

Definitive management thereafter involves three forms of treatment: anticoagulation, thrombectomy or thrombolysis in any combination.<sup>1,6-8</sup>

The purposes of thrombectomy is to prevent thrombus propagation and gangrene, prevent pulmonary embolism and to avoid post phlebotic syndrome.<sup>13</sup> Thrombectomy for iliofemoral DVT had a patency rates of 85 percent if performed within 10 days of the onset with normal legs or minimal oedema in 81 percent of survivors.<sup>11</sup> For PCD and venous gangrene, higher rates of rethrombosis have been reported after thrombectomy.<sup>14</sup> A 5-year follow-up in patients with good early results revealed 94 percent of oedema and stasis requiring compression stocking.<sup>15</sup> Two-thirds of postoperative deaths resulted from pulmonary embolism.<sup>15</sup> Thrombectomy fails to clear thrombus distally from small venules and capillary, with poor results in patients with venous gangrene.<sup>16,17</sup> An adjunctive temporary distal arteriovenous fistula improved outcome of venous thrombectomy.<sup>18,19</sup> The objectives of temporary distal arteriovenous fistula, which is closed 3 months later, are to increase blood flow in the thrombectomized segment to prevent immediate rethrombosis, to allow time for healing of the endothelium and to promote the development of venous collateral in case of incomplete clearance or immediate rethrombosis.<sup>18-20</sup> Fasciotomy offers advantages in reducing compartment pressures.<sup>21</sup> Amputation for PCD and venous gangrene is necessary in 20-50 percent of patients.<sup>17,22</sup> Amputation in venous gangrene should be delayed as long as possible while aggressive treatment is pursued to allow venous channels to open, limb swelling to subside and the extent of tissue loss to be established.<sup>17</sup>

Our experiences in 15 patients with PCD and venous gangrene of 125 DVT patients revealed. six patients underwent immediate venous thrombectomy for the reason of impending gangrene (2) and failure of initial management (4) with anticoagulation, fluid resuscitation, bed rest with leg elevation for 6-12 hours. Limbs salvage was achieved after intraoperatively clearance of iliac vein thrombosis was performed by using vascular scope or pediatric bronchoscope as well as temporary arteriovenous fistula (AVF) to prevent rethrombosis in all 6 patients. After operation, patency of iliofemoral vein can be evaluated with ultrasonography or duplex scan.

Nine patients with venous gangrene under went

venous thrombectomy. Temporary distal arteriovenous fistula performed in patients with moderate oedema and vascular structures were could be clearly identified. For the patient with massive oedema, fasciotomy was done to relieve compartment pressure (12 extremities). After venous thrombectomy and/or fasciotomy, limb swelling subsided rapidly and extent of the tissue loss was established with line of demarcation for easier consideration of the level of amputation. Seven transmetatarsal and 5 below-knee amputation were done. Two retroperitoneal caval interruptions were done because of extension of thrombosis from iliofemoral vein to IVC detected by CT scan. There was no immediate mortality and no pulmonary embolism was encountered. Closure of temporary distal arteriovenous fistula was performed 3 months postoperatively. Seven of nine patients with malignancy died in one year after the operation. Five patients were lost to follow-up at 6 months to 2 years. Only 2 patients have a regular follow up up to 5 years without post phlebotic syndrome.

Thrombolysis offers an attractive method of treatment for both PCD and venous gangrene.<sup>23-25</sup> Thrombolytic agents can be delivered into the occluding thrombus or intraarterially,<sup>25</sup> allowing lysis in both major veins and smaller venous channels that are inaccessible to surgery, while preserving of venous collaterals and normal venous valve function. These advantages should be considered and weighted against any conditions contraindicated to thrombolysis.<sup>23,24</sup> We have no experience in thrombolytic therapy.

## CONCLUSIONS

Ilio-femoral DVT, particularly with PCD or venous gangrene, is a limb and life-threatening condition. Our experience suggested that aggressive treatments with venous thrombectomy and temporary distal arteriovenous fistula yielded good results with less immediate rethrombosis particularly when the treatment was started as early as possible. Thrombectomy combined with a temporary distal arteriovenous fistula appeared to give superior results compared with conservative anticoagulant treatment. Because of improved preoperative management and surgical technique with special precautions in patients with extension of the thrombus into the inferior vena cava, the results of surgery have improved. The use of



perioperative vascularscopy to demonstrate clearance of the iliac vein, as well as the adjunctive temporary distal arteriovenous fistula, will decrease the risk of rethrombosis.

There is an absolute indication for surgery in patients with PCD and venous gangrene to save life and limb. Thrombectomy with a temporary distal arteriovenous fistula is a better operation and can achieve specific goals of restored venous patency, limb viability and reduced mortality in comparison to the standard conservative treatment alone.<sup>13</sup>

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# *Factors Influencing Health Status of Caregivers of Postoperative Neurosurgical Patients*

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## **Abstract**

**Background:** Becoming caregivers effects individuals' lives and health especially when people have to adapt to the role of caregivers of severely ill patients, such as neurosurgical patients.

**Objective:** This research was a descriptive study, based on transition theory, aiming to analyze the factors influencing the health status of caregivers of postoperative neurosurgical patients.

**Materials and Methods:** The participants were 110 primary caregivers taking care of postoperative neurosurgical patients at home, at least 3 weeks after hospital discharge. Data collection was conducted at the Neurosurgical Out-Patient Department, Blumibol Adulyadej Hospital, from January to February of 2002, using the Demographic Questionnaire, Extended Glasgow Outcome Scale, Short Sense of Competence Questionnaire, Personal Resource Questionnaire 85 Part 2, Denyes & Filday Dependent-Care Agency Instrument, Appraisal of Caregiving Scale, and Laffrey Health Conception Scale. To analyze the data, descriptive statistics, Pearson's Product Moment Correlation, and Stepwise Multiple Regression were employed.

**Results:** The majority of caregivers were female (80%) whose ages ranged from 41 to 60 years (Mean = 47.23, SD = 18.08). More than half of the caregivers were married (73.6%), and 29.1 per cent of them were housewives or housekeepers. Nearly half of the participants had sufficient income with saving money (47.3%), while 32.7 % of them had sufficient income without saving money and 20% of them had insufficient income with debts. The most common relationship of caregiver to the patient was that of spouse (42.7%), and most caregivers had secondary caregivers to help them take care of their patients (72.7%). About thirty-six percents of primary caregivers had some disease or illness before becoming caregivers, while 62.7 per cent developed physical symptoms, diseases or illness during caregiving. The results indicated that capability of caregiver and social support had a positive relationship to the health status of caregivers ( $p < 0.001$ ), but stress and sense of competence, had a negative relationship to the health status of caregivers ( $p < 0.001$  and 0.05). The Stepwise Multiple Regression Analysis showed that capability of caregiver, together with stress, could explain the variation of health status of caregivers of postoperative neurosurgical patients by 27.7 per cent

**Conclusion:** Nurses and other health care providers should encourage promoting health status of caregivers by establishing a training program that focuses on the capability of caregivers and knowledge and skills training in regard to caregiving, providing a stress reduction program, and supplementing the supportive resources in caregiving to reduce the burden of caregivers, which will lead caregivers to good health.

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Neurosurgical operations are the treatment of preference for patients who suffered various neurological diseases including trauma. These procedures provide a greater chance for neurosurgical patients to survive.<sup>1</sup> Statistical information concerning public health in Thailand were lacking of details in specific group of neurosurgical patients' data.<sup>2</sup> The existing

data regarding neurological patients and other neurosurgical conditions included brain tumor, intracranial hemorrhage, vascular malformation, head injury, and traumatic brain injury. Research conducted in other counties with neurosurgical patients undergoing surgery had also shown that patients suffered from severe brain damage had a greater chance of survival

due to advance technology in relation to diagnosis, medical, surgical procedures and postoperative cares.<sup>3,5</sup>

Nevertheless, neurosurgical procedures could not immediately correct pathological lesions in the brain that cause patients disabilities or problems with immobilization, speech, swallowing, excretion control, and communication difficulties. In other words, a neurosurgical operation may save the patients' life, but disability and morbidity after the surgery are still be largely present.

Although, some patients can resume their previous physical functions but this takes time. Thus, the patients have to depend on family caregivers to undertake the burden of providing continuous care to the dependent patients. These caregivers usually are family members, relatives, or spouses, but sometimes they can be colleagues or close friends of the patients. Furthermore, caregiving is a complex, difficult, and potentially unfamiliar task for many caregivers; thus, it could lead to the caregivers' feelings of exhaustion and irritation resulting from insufficient rest, irregular eating habits, and exposure with emotional disturbance of the patients as well as the rehabilitative problems at home. As a result, these caregivers might experience the feelings of despair, hopelessness, and worry. In short, persons who have to undergo the transition to being caregivers of neurosurgical patients at home have to cope with various problems which could lead not only to adverse effects on the caregivers' health but also to other indirect psychological, emotional, and social problems. Moreover, the caregivers have to adjust themselves to perform the continuous caregiving role, family roles, and social roles as well as to the work roles as they have to provide care to the patients at home. Caregivers are very important in the rehabilitation process of the patients who have been discharged from the hospital. They can help promote the patients' well-being to live in society. However, these caregivers should have good health themselves so that they can maintain the quality of care provided to the patients. Little is known about the factors influencing the maintenance of health status of caregivers during the transition period to a caregiver's role. Therefore, the present study aimed to investigate the health status of caregivers of postoperative neurosurgical patients. In particular, it aimed to explore influencing factors which affect the transition to caregivers of neurosurgical patients after being discharged from the hospital leading to quality and effective caregiving. It was expected that the findings

of the present study could provide a guideline for nurses to understand various factors affecting the health status of caregivers of postoperative neurosurgical patients so as to be able to improve the quality of nursing care to this group of patients.

## MATERIALS AND METHODS

The participants were 110 caregivers, 80 per cent (88/110) of them were female whose ages ranged from 15 to 76 years old, with the mean age of 44.61 years (SD = 13.08). About three-quarters (81/110 or 73.6%) were married; 72.7 per cent (80/110) had secondary caregivers to help them taking care of their patients. The largest group of subjects were housewives and completed elementary education. In addition, nearly half of the subjects (47.3%) had sufficient income with saving money, 42.7 per cent were spouses of the patients. The majority of primary caregivers (67/110 or 60.9%) spend 24 hours taking care of the patients; 62.7 per cent (69/110) had physical symptoms diseases before they started caregiving.

The present study used purposive sampling to select the subjects based on the aforementioned criteria from January to February 2002. One hundred and ten participants were recruited to take part in the study from. A questionnaire survey was performed at the Neurosurgical Out-patient Department, Bhumibol Adulyadej Hospital, where recent past statistics recorded 2,950 and 2,803 neurosurgical patients came to follow-up in 2000 and 2001, respectively.

*The data were collected by employing the following instruments.*

1. The demographic characteristics questionnaire of caregivers and their patients included sex, age, educational level, marital status, occupation, financial status, period of illness, health problems, and co-morbidity of patients, numbers of hours spent taking care of the patients each day, period of time spent taking care of the patients after discharge, relationship with the patient, number of secondary caregivers, underlying disease and other physical symptoms or illness that may occur while providing care to the patients.

2. The Extended Glasgow Outcome Scale (GOSE) was developed from GOS by Wilson and colleagues<sup>6</sup>; it was translated into Thai by Thosingha O<sup>7</sup> and two bilingual linguists were also asked to check the accuracy of the language. Cronbach's alpha coefficient for the scale was 0.98 and the kappa value

for this scale was 0.74.

3. The Short Sense of Competence Questionnaire (SSCQ) was developed from SCQ by Vernooij-Dassen and colleagues<sup>7</sup> which consisted of 7 items; it was translated into Thai by Thosingha O and others<sup>8</sup> and backtranslated by two bilingual linguists. Cronbach's alpha coefficient for this questionnaire was 0.72.

4. The Personal Resource Questionnaire 85 part 2 (PRQ 85 part 2) was adapted from PRQ 82 by Weinert<sup>9</sup> which consisted of 25 items; it was translated into Thai by Sinsuksai N.<sup>10</sup> Cronbach's alpha coefficient for this questionnaire was 0.84.

5. The Denyes & Filday Dependent-Care Agency Instrument was developed by Denyes<sup>11</sup> and subsequently translated into Thai by Somnarin O<sup>12</sup> which consisted of 31 items. Cronbach's alpha coefficient for this questionnaire was 0.82.

6. The Appraisal of Caregiving Scale was adapted from Oberst<sup>13</sup>; it was translated into Thai by Gasemgitvatana S<sup>14</sup> which consisted of 22 items divided in to two categories. Cronbach's alpha coefficient for this questionnaire was 0.93.

7. The Laffrey Health Conception Scale (LHCS) was developed from "Health Conception Scale" by Laffrey<sup>15</sup> which consisted of 28 items; it was translated into Thai and tested its language by two bilingual linguists. Cronbach's alpha coefficient for this questionnaire was 0.89.

## Analysis

The data collected were analyzed using the SPSS/PC (Statistical Package for the Social Personal Computer Plus) that included descriptive statistics, Pearson's Product Moment Correlation, and Stepwise Multiple Regression.

## RESULTS

The majority of caregivers were female (88/110 or 80%), whose age ranged from 41 to 60 years (Mean = 47.23, SD = 18.08). More than half of the caregivers were married (80/110 or 73%) and 32/110 (29.1%) of them were housewives or housekeepers. Nearly half of the participants had sufficient income with saving money (52/110 or 47.7%), while 36/110 (32.4%) of them had sufficient income without saving money, and 22/110 (19.8%) of them had insufficient income with debts. Forty seven caregivers were patients' spouses (42.7%) and most of them (80/110 or 72%) had

**Table 1** Demographic characteristics of the caregivers of Neurosurgical patients (n = 110)

Characteristics	Number	Percent
Sex		
Male	22	20.0
Female	88	80.0
Age (years)		
< 20	4	3.6
21-40	40	36.4
41-60	51	46.4
> 60	15	13.6
Marital Status		
Single	22	20.0
Couple	81	73.6
Widowed, divorced, separated	7	6.4
Educational Level		
No educational	5	4.5
Elementary level	43	39.1
High school	24	21.8
Diploma	20	18.2
Bachelor degree of higher	18	16.4
Occupation		
Government officer	7	6.4
Trader	27	24.5
Employee	16	14.5
Unemployed	11	10.0
Pensionary	8	7.3
House wife	32	29.1
Others	9	8.2
Caregivers' financial status		
Insufficient income with debts	22	20.0
sufficient income without saving money	36	32.7
Sufficient income with saving money	52	47.3
Hour of caregiving (per day)		
6-9	4	3.6
10-13	31	28.2
14-17	3	2.7
18-20	5	4.6
24	67	60.9
Relation of caregiver		
Spouse	47	42.7
Bother/sister	7	6.4
Son/daughter	26	23.6
Father/mother	21	19.1
Others	9	8.2
Secondary caregivers		
No secondary caregiver	30	27.3
Had secondary caregivers	80	72.7
Underlying diseases (UD)		
No problems	71	64.5
Had UD before caregiving	39	35.5
- Hypertension	8	20.5
- Hypertension c DM or Rheumatoid	3	7.7
- Knee, Back, Neck pain, or Ostalgia	6	15.4
- Allergy	5	12.8
- DM	3	7.7
- High cholesterol	3	7.7
- Headache oMigraine	3	7.7
- Others	8	20.5
Caregivers' illness during caregiving		
No problems	41	37.3
Had physical symptoms or illness*	69	62.7
- Backache	18	26.1
- Knee pain	17	24.6
- Ostalgia or neck, shoulder pain	11	15.9
- Headache c itching	17	24.6
- Heartburn or abdominal pain	7	10.1
- Fatigue	6	8.7
- High cholesterol	3	4.3
- Insomnia	2	2.9
- Others	7	10.1

\*Each Participant reported more than one physical symptom or illness

**Table 2** Demographic characteristics of the postoperative Neurosurgical patients (n = 110)

Characteristics	Number	Percent
Sex		
Male	88	80.0
Female	22	20.0
Age (years)		
< 20	7	6.4
21-40	38	34.5
41-60	36	32.7
> 60	29	26.4
Marital Status		
Single	29	26.4
Couple	67	60.9
Widowed, divorced, separated	14	12.7
Educational Level		
No educational	2	1.8
Elementary level	36	32.7
High school	35	31.8
Diploma	24	21.8
Bachelor degree of higher	13	11.8
Family Status		
Head of family	68	61.8
Member of family	42	38.2
Occupation		
Government officer	20	18.2
Employee	12	10.9
Unemployed	45	40.9
Pensionary	16	14.5
Others	17	15.5
Average income per month (Baht)		
No income	40	36.4
< 5,000	19	17.3
5,001-10,000	23	20.9
> 10,000	28	25.4

secondary caregivers to help them taking care of their patients. It was also found that 39/110 (35.5%) of them had some disease or illness before becoming caregivers, while 69/110 (62.7%) of them developed physical symptoms, diseases or illness after they became the caregivers of postoperative neurosurgical patients (Table 1).

The majority of the patient participants (88/110 or 80%) were male. The average age of the participants were 47.23 years, and 67/110 (60.9%) were married. In addition, 45/110 (40.9%) of them were unemployed, and 40/110 (36.4%) did not have personal income even though more than half of them (68/110 or 61.8%) were the head of the family. Therefore, they were heavily dependent for resources and incomes of their families and the caregivers (Table 2).

The mean score of the LHCS was 132.45 (range: 79-161) indicating relatively high health status of caregivers. The scores in health status scores of functional or role performance health perception, adaptive health perception, and eudaimonistic health perception were all greater than the clinical health perception (Table 3).

Significantly, capability of caregiver and social support, had positive relationship to status at  $p < 0.001$  ( $r = 0.464$  and  $0.335$ ), while stress and sense of competence had negative the health of caregivers at  $p < 0.05$  level ( $r = -0.367$  and  $-0.205$ ), but severity of illness and caregiver's illness during caregiving did not

**Table 3** Level of health status in caregivers of postoperative Neurosurgical patients (n = 110)

Variables	Possible Range	Actual Range	Mean	SD
Health status	28 - 168	79 - 161	132.45	16.92
Clinical health perception	7 - 42	7 - 42	24.05	7.85
Function / Role performance	7 - 42	18 - 42	37.44	4.45
Adaptive health perception	7 - 42	20 - 42	35.91	4.53
Eudaimonistic health perception	7 - 42	19 - 42	34.84	5.45

**Table 4** Correlation between Severity of illness, Sense of Competence, Capability of caregiver, Social Support, Stress, Caregiver's illness during caregiving and Health Status (n = 110)

Variables	1	2	3	4	5	6	7
1. Sense of Competence	1.000						
2. Severity of illness	.246**	1.000					
3. Capability of caregiver	-.155	.073	1.000				
4. Social support	-.098	.031	.450***	1.000			
5. Stress	.521***	.281**	-.276**	-.333***	1.000		
6. Caregiver's illness during caregiving	.014	.229**	.008	-.080	.091	1.000	
7. Health status	-.205*	.014	.464***	.335***	-.367***	-.014	1.000

\* $P < 0.05$ . \*\* $P < 0.01$ . \*\*\* $P < 0.001$



**Table 5** Capability of caregiver and stress regressed on health status of caregivers of postoperative neurosurgical patients (n = 110)

	R	R <sup>2</sup>	R <sup>2</sup> change	F change	B	Beta
Model 1						
Capability of caregiver	.464	.216 (21.6%)	.216 (21.6%)	29.685	.238	.464
Model 2						
Capability of caregiver and Stress	.527	.277 (27.7%)	.062 (6.2%)	9.139	.201 -.294	.393 -.258

correlate with caregivers' health status (Table 4).

The result obtained from the stepwise multiple regression analysis showed that capability of caregiver and stress predicted the variation of health status of caregivers of postoperative neurosurgical patients by 27.7 per cent (Table 5).

## DISCUSSION

The findings that 88 caregivers subjects, or 80 per cent, were female, and 73.6 per cent of them were married were in congruence with previous studies that most of caregivers were female.<sup>14,16,17</sup> Almost half of the caregivers or 46.4 per cent, were between 41 and 60 years old. Since they themselves were middle-aged, they began to face with various health problems, especially female caregivers who experienced the menopausal symptoms which could affect them physically, psychologically, and emotionally due to the hormonal changes. As such, it was found that 69/110 (62.7%) of these caregivers had developed health problems including backache and knee pain which could be resulted from having to lift or move their patients. In this study, the caregivers' average hours spent on taking care of patients per day was 19.49 hours. Likewise, previous studied of Kenchaiwong F<sup>18</sup> reported that the average hours per day caregivers spent on caregiving was 19.70 hours. Devoting almost all of their time and energy taking care of patients can greatly affect their own health. As a results the score of clinical health perception was lower than other dimensions. However, it is worth noting that clinical health perception does not mean the total health condition of a person, as a person's holistic health condition is also dynamically related to the person's environment as well as how well a person adapt to their physical problems.<sup>19</sup> These caregivers could very well perform their role even though they had to take up the role of a caregiver in addition to the other roles they already had, so that the score of role performance/

functional health perception were highest than those for all other dimensions. Although 39/1110 (35.5%) of the caregivers who took part in the present study had some form of health problems prior to becoming caregivers, and 69/110 (62.7%) experienced health problems during caregiving, they still showed relatively second highest scores on adaptive health perception (Mean = 35.91, SD = 4.53). The caregivers were able to adapt and performed their caregiver roles relatively well despite that the responsibilities of the caregivers roles may become an added burden. The score of eudaemonistic health perception (Mean = 34.84, SD = 54.5) came in the third rank indicated that providing care for neurosurgical patients might have affected happiness in the caregivers' life.

Our study revealed that, capability of caregiver, stress, and social support were significantly related to caregivers' health status ( $p < 0.001$ ), while sense of competence was less significantly related to caregivers' health status ( $p < 0.05$ ). The Stepwise Multiple Regression Analysis indicated that capability of caregiver could explain 21.6 per cent of the variance when stress was added (Table 5). As such, it could be said that the most important factor that would enable the patients to undergo transition was the caregivers' capability in taking care of the patients. If the caregivers are lacking of capability, they may have to spend more time taking care of the patients, and thus, have less time to take care of themselves. They would eventually have worsened health status.

This findings are congruent with the previous studies<sup>20,21</sup> which found that an increase in knowledge and skill development is necessary for family caregivers of postoperative neurosurgical patients during their transitional period from hospital to home. This notion is also supported by Schumacher and Meleis<sup>22</sup> who asserted that planning for knowledge and development necessary during the transition would enable individuals to go through the transition period successfully.

Stress is another important factor that could explain

caregivers' health status by 6.2 per cent (Table 5). In general, if caregivers feel that their caregiving responsibility is stressful, their health could be adversely affected – both mentally and physically. Likewise the study of Lezak<sup>23</sup> pointed out that caregivers tend to experience stress at a high level, as well as depression and loneliness, all of which resulted from the heavy burden of taking care of the patients.

### CONCLUSION

The results of this study evidently supported that capability regarding caregiving and stress in caregiving were the important factors effecting the health status of caregivers of postoperative neuro-surgical patients.

Caregivers' training that focus on knowledge and skill in regard to caregiving and stress reduction programs for caregivers are important in fulfilling the role of caregivers responsibilities.

Social support was positively correlated with caregivers' health status. Nurses should therefore facilitate caregivers in gaining access to all available resources necessary for the caregivers' as well as the patients' health.

During each follow-up treatment, caregivers' health problems or complaints should be carefully assessed and managed. Nurses who work at the follow-up department should pay more attention on caregivers' health. Counselling program for caregivers is worthy of achieving balance between caregivers' self-care and providing care for the patients.

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# Trauma and Injury Severity Score (TRISS) in Head Injury Patients

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## Abstract

**Background :** Injury severity classifications have been developed for the past decades. Milestone study in the quest for the best possible method to predict outcomes of injured trauma patients has been studied continuously. Quantitative characterizations of injury are essential for research, meaningful evaluations of patient outcome, quality improvement, and prevention programs. Trauma and Injury Severity Score (TRISS) is a combination index based on then state-of-the-art severity indices, the Trauma Score (TI) and the Injury Severity Score (ISS), patient age, and mechanism of injury. Since its development, TRISS has been a frequently used method for predicting survival or mortality of trauma inpatients, but unfortunately not many studies had reported about using TRISS with neurotrauma cases.

**Materials and Methods :** A retrospective study to determine the accuracy of TRISS in head-injured patients was made by review of medical records of patients admitted between December 2000 and May 2001 to Trauma Unit of Saraburi Hospital were reviewed by trauma audit staffs consisting of various specialties such as general surgeons, neurosurgeons, urologists and plastic surgeons.

**Results :** The results of this study showed that there were many drawbacks of using TRISS in predicting the death of neurotrauma patients. TRISS model did not work well in predicting survival for neurotrauma patient.

**Conclusion :** Because of the limitations of TRISS, peer reviews or other new models such as ICISS should supersede it. Some possible refinements such as the mechanisms of injury, timing of injury, nature of diseases, hospital charges, and the prognosis should be included in the models in predicting the neurotrauma outcome.

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Characterization of injury severity emerged in the 1950s.<sup>1</sup> Since then more methodologies were subsequently developed.<sup>2,3</sup> Up to now, numerous scoring methods had been designed and proposed. One of the most popular trauma classification,

especially for neurosurgical trauma, is Glasgow Coma Scale (GCS) described by Teasdale and Jennett.<sup>4</sup>

Abbreviated Injury Scale (AIS) and Injury Severity Score (ISS) are classified as anatomic scores, whereas Trauma Score (TS), Revised Trauma Score (RTS), and GCS are physiologic scores. Trauma and Injury Severity Score (TRISS) is the combined anatomic and physiologic score.<sup>5-15</sup> RTS, ISS and TRISS were the

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well-known scoring methods widely employed in the late 1990s. International Classification of Disease-9 based Injury Severity Score (ICISS) has been shown to be a much better predictor of survival than ISS in injured patients in one study.<sup>16</sup>

RTS was developed from the original Triage Index (TI) and Trauma Score (TS) derived from application of code values for GCS, Systolic blood pressure (SBP), and Respiration rate (RR) by the following formula<sup>17-19</sup>:

$$RTS = 0.9368 \text{ GCS}(c) + 0.7326 \text{ SBP}(c) + 0.2908 \text{ RR}(c)$$

ISS correlates reasonably well with mortality probability but it has the main drawback in that it can not be accounted for severe multiple injuries within one region.<sup>16,20-25</sup>

TRISS combines the physiologic RTS together with anatomic ISS and then formulate together with patient age, injury type and become a well-known trauma patient triage. It is calculated using the collected information databases and expressed as the survival chance of trauma victims.<sup>26</sup>

All of the injury scores methods are related to each other in some aspects. For example, Trauma Score (TS) has some linkage with the original Glasgow Coma Scale (GCS). However, each method has its shortcomings and drawbacks. There had been several debates regarding which method is the best under certain specific events. So "new and improved systems" were frequently put forth. The most recent revision in the year 2000 was ICISS 10 (ICD-10 based).

Although several reports had pointed out the main drawbacks of TRISS method, but it is still a widely used system for outcome analysis. However, not many had discussed about TRISS as regarded to the neurological outcome. This study analyzed the data obtained from hospital medical records of a provincial hospital in Thailand during a recent 6-month period to identify the accuracy of TRISS method in predicting the chance of survival in head injury patients.

## MATERIALS AND METHODS

Saraburi Hospital is a provincial hospital situated in close proximity of major highways just north of Bangkok. The hospital maintains an active Emergency and Trauma services.

The medical records of patients admitted between

December 2000 and May 2001 to Trauma Unit of Saraburi Hospital were reviewed by trauma audit staffs consisting of various specialties such as general surgeons, neurosurgeons, urologists and plastic surgeons.

The following inclusion criteria were used: (1) Patients with history of trauma (traffic accidents, body assault, etc.); (2) patients with co-existing head injuries; and (3) patients that succumbed. Patients without head injuries and/or age less than 15 years were excluded from this review.

All patients had records of their ages, vital signs (systolic blood pressure, heart rate, respiratory rate), and their neurosurgical signs using the Glasgow coma scale from the time of admission. Data were reviewed and calculated into Glasgow coma score (GCS) and Trauma Score-Injury Severity Score (TRISS). Using multiple logistic regression models, the differences between blunt and penetrating injuries related to TRISS is accommodated. Then, together with RTS, ISS, and patient age, they were placed in a logistic transformation to yield a survival probability (Ps) in the range from 0 to 1.<sup>27</sup>

The logistic formula is :

$$Ps = 1 / (1 + e^{-b})$$

Where b is calculated from :

$$b = b_0 + b_1(RTS) + b_2(ISS) + b_3(\text{Age Index})$$

$$e = 2.7183 \text{ (based of Napierian logarithm)}$$

$$\text{Age index} = 1 \text{ for patient's age} > 54 \text{ years}$$

$$\text{Age index} = 0 \text{ for patient's age} \leq 54 \text{ years}$$

The coefficients b<sub>0</sub> to b<sub>3</sub> are derived from multiple regression analysis of MTOS database and are different from blunt to penetrating injury.<sup>28</sup>

Thus, the determination of Ps varies according to 6 variables of GCS, SBP, RR, Age, Mechanism of trauma, and the ISS.

There were 176 patients matched with the above criteria. The patients who met the above criteria with TRISS > 0.8 and should have a predicted chance of survival were divided according to GCS into 3 groups. Group I were those with GCS 13-15, Group II 9-12, and Group III 3-9. Trauma audit teams serving as peer review teams, were assigned to study each medical record in details.

Conclusions were reached from peer review to address the chance of individual survival of all patients. The cause of death and the reason or factor contributing to management and survival failures were identified in

those with TRISS > 0.8 who should have a chance of survival. For those without any chance of survival, TRISS < 0.8, only the possible cause of death was determined.

## RESULTS

There were 176 patients matched with the above criteria. Among them were 145 males and 31 females.

**Table 1** Cause of injury in TRISS < 0.8

Cause of Injury	No. of Patient	Percent
Motorcycle Accidents	62	47.7
Car Accidents	22	16.9
Body Assaults	22	16.9
Gun Shot Wounds	10	7.7
Falls from Height	9	6.9
Others	5	3.9
<b>Total</b>	<b>130</b>	<b>100.0</b>

**Table 2** Causes of death in patients with TRISS < 0.8

Cause of Death	No. of Patient	Percent
Severe Shock	74	42.0
Brain Herniation	44	25.0
Respiratory Failure	32	18.2
Sepsis	23	13.1
Unknown	3	1.7
<b>Total</b>	<b>176</b>	<b>100</b>

The most common cause of trauma was motorcycle accident (143/176 cases or 81.25 %). The others were car accident, body assault, gunshot wound, falling from height.

One hundred and thirty patients had TRISS < 0.8 at time of arrival at the Emergency Room. There were 46 of 176 patients who had TRISS above 0.8 and they were divided into 3 groups according to their GCS. There were 28 patients in Group III, 11 in Group II, and 7 in Group I. For those patients with TRISS < 0.8, their types of injury and causes of death were shown in Tables 1 and 2 respectively.

The Group I patients were considered should have a survival chance because of their high GCS and TRISS > 0.8 (Table 3). In this group, however after details peer review, 6 patients were considered having high probability of death by the following conclusions.

Case 1 and Case 6 were the cases of severe brain edema (fungating brain) that resulted from high speed motor cycle accident (MCA). The patients came to the hospital very soon after the accident, so their GCS were high. Despite aggressive management for brain edema, the patients died. In case 1, his family agreed not to receive further postoperative aggressive treatment due to the unacceptable poor prognosis. His family could not afford the living cost at home for his prolonged vegetative state.

Case 2 and Case 5 were the cases of posterior fossa epidural hematoma. These two patients showed no early signs of uncal herniation. The only complaints

**Table 3** Summary of Group 1 patients (N = 7)

Sex	Age (yr)	Cause of Injury	GCS at adm.	Ps	Diagnosis on Admission	Final Diagnosis	Cause of Death	Ls. (D)	
1	M	19	MCA	13	0.98	SDH with brain edema	Same with Severe brain edema	Tonsillar herniation	3
2	F	20	MCA	15	0.89	Brain concussion	Posterior fossa EDH	Tonsillar herniation	6
3	M	33	MCA	13	0.90	Brain concussion	Ruptured liver with massive hemorrhage	Brain hypoxia and edema from prolonged shock	12
4	M	18	GSW	13	0.87	Open skull fracture	Ruptured traumatic intracranial aneurysm	Massive SAH with severe brain edema	24
5	M	21	Assault	13	0.94	Brain contusion	Posterior fossa EDH	Tonsillar herniation	9
6	F	24	MCA	13	0.82	Bilateral SDH	Same with severe brain oedema	Tonsillar herniation	6
7	M	23	MCA	14	0.88	EDH	EDH	Delayed surgery	11

(Abbreviation code: yr - year, SDH-Subdural haematoma, EDH-Epidural haematoma, ICH-Intracerebral haematoma, SAH-Subarachnoid haemorrhage, MCA-Motorcycle accident, GCS-Glasgow Coma Score, Ps-Probability of survival, Ls-Length of stay as Day, Adm.-Admission)



**Table 4** Summary of Group 2 patients (N = 11)

	Sex	Age (yr)	Cause of Injury	GCS at adm.	Ps	Diagnosis on Admission	Final Diagnosis	Cause of Death	Ls. (D)
1	F	18	MCA	10	0.82	SDH with brain oedema	Severe brain oedema	Tonsillar herniation	8
2	F	45	Fall from height	10	0.82	SDH	Severe brain oedema	Respiratory failure	12
3	M	20	MCA	12	0.92	ICH	Same with SDH	Tonsillar herniation	1
4	M	21	MCA	9	0.96	Posterior fossa EDH	Same	Respiratory failure	4
5	M	35	MCA	8	0.89	Open skull fracture	Same with SDH-ICH	Tonsillar herniation	7
6	M	65	Car accident	8	0.95	Brain concussion	Fracture pelvis	Hypovolemic shock	2
7	F	16	Fall from height	10	0.97	Spinal cord injury (SCI)	Same	Respiratory failure	21
8	M	18	MCA	12	0.86	SDH-ICH	Same	Sepsis	16
9	M	19	Body Assault	11	0.88	Spinal cord injury (SCI)	Same	Respiratory failure	7
10	F	23	MCA	10	0.90	ICH	Same with SCI	Respiratory failure	12
11	M	31	Car accident	9	0.90	SAH with Severe brain edema	Ruptured intracranial aneurysm	Brain herniation	6

*N.B.*

a) Case 2, 4, 6, 7, 8, 9, and 10 died from complications related to respiratory and infectious problems, not from the diseases themselves.

b) Case 11 died from process of ruptured intracranial aneurysm, not from the injury of accident.

**Table 5** Summary of Group 3 patients (N = 28)

GCS on Admission	No. of Patients
GCS = 3	15
GCS = 4	4
GCS = 5	2
GCS = 6	5
GCS = 7	1
GCS = 8	1
<b>Causes of Death</b>	
Tonsillar herniation	18
Severe Shock	5
Sepsis, Respiratory failure, etc.	5

*N.B.*

a) This group was not studied in details because peers review agreed that most patients had high possibility of death due to low GCS on admission.

b) Most patients died because of tonsillar herniation from severe head injury despite their Ps > 0.8.

were headache, nausea and vomiting which were commonly found in most of cases of mild head injury. The correct diagnosis could not be made prior to further deterioration. The progression of this type of injury was rapid and moribund.

Case 3 was a referred case from a rural hospital

with the diagnosis of head injury with abdominal trauma. He died from cardiovascular collapse resulted from prolonged shock during transportation, despite early surgery for stopping bleeding from rupture of the liver. His GCS of 13 at the time of admission resulted from hypovolemic shock, not from primary brain injury.

Case 4 died from ruptured traumatic aneurysm of intracranial vessel injury. He received open fracture of skull from gunshot wound. His condition was stable and GCS was much improved 7 days after admission. But on the 8th day, his GCS rapidly dropped to 5 and the investigation showed traumatic intracranial aneurysm at right pericollousal artery with massive intracranial and subarachnoid hemorrhage. Despite aggressive immediate surgery by craniectomy, he could not survive.

Case 7 was the only case with a predicted chance of survival after studied by peer review. This patient had epidural hematoma from motorcycle accident and arrived at the hospital with TRISS > 0.8 and GCS of 14. Early craniotomy could have saved his life but unfortunately he died due to delayed diagnosis and

surgery after the admission.

Groups II and III patients (11 and 28 cases respectively) despite the favorable TRISS  $> 0.8$ , were considered to have very poor chance of survival after studied by peer review. Data of cases in Group II and III were summarized in Tables 4 and 5 respectively.

## DISCUSSION

Among patients with multisystem trauma, the head is the most frequently part of the body injured. Head injury contributes significantly to the outcome in one half of all deaths from trauma.<sup>29</sup> Almost 75% of victims of fatal traffic accidents demonstrate post-mortem evidence of brain injury.<sup>30</sup> One can not deny the fact that majority of trauma mortality is head injury. Such statistics become more alarming when one realizes that, unlike those who succumb to the other leading causes of death, the victims of head-injury are often adolescents or young adult.<sup>31</sup> This causes much financial burden in terms of both lost productivity and cost of medical care. So numerous predictive formulas have been suggested for evaluation of head-injured patients.<sup>32</sup>

In head-injured patients, there are specific events that made the cases different from other traumatized cases, abdominal injury for example. It has been known that once the impact occurred at the scene, there are 2 specific events that occurred. The first is primary injury of the CNS, and the latter more serious ongoing event is secondary injury. What happened at the scene of accident does not matter for the neurosurgeon because once the impact has occurred we could do nothing to lessen the force that already struck the victims. What neurosurgeons can do is to treat the oncoming secondary injury, i.e. intracranial hematomas such as epidural hematoma, subdural hematoma, and intracerebral hematoma. Using TRISS method as the means of predicting the probability of survival (Ps) may correlate well with this group of neurotrauma patients. The mortality can be reduced by early evacuation of the secondary expanding lesion (blood clots). In most cases, the faster evacuation made, the better the outcome of the patients is. This is especially true if the pre-operative status of the patients is good. The nature of expanding hematomas in the cranium is also important. Patients with subdural hematomas usually have much worse prognosis than

that of epidural hematomas of equal size, mass effect, duration of neurologic impairment, and duration of time since the impact.<sup>31</sup> In subdural hematoma, mechanical force applied to the head is usually diffuse throughout the brain parenchyma and resulted in both intracranial clots and extensive underlying parenchymal damage.

For brain edema and other types of lesion that present as the sequelae of severe head injury such as subarachnoid hemorrhage, diffuse axonal injury, surgical method plays less important role or in some cases takes no role. In case of brain edema, neurosurgeons can not remove the brain tissue so much to lessen the increased intracranial pressure effect. Intracranial pressure (ICP) may decrease after craniectomy but the edematous process continues. If ICP is decreased much enough to comfort the cranium, the edematous process is not much dreadful, and the patients' condition is healthy enough; the patient may be improved by aggressive medical treatment for the stage of increased ICP. If not, patients will die no matter we do. In most cases of diffuse axonal injury, we can hardly see any abnormal anatomical lesions on the imaging investigation but the functional aspect of brain neuronal integrity had been damaged,<sup>33,34</sup> and there is no effective treatment for diffuse axonal injury at present. If the axon is not severely injured, then the optimal internal milieu and proper medical care may allow it to recover, whereas secondary insults may seal itself.<sup>35</sup> This group is clear for what we call "time-dependent process." The patient may look well immediate after injury or at first seen in the emergency room (ER), but the process is going to develop silently. Maybe a few hour after, he may be look much different from the past few hour. If TRISS is calculated at the first seen at ER, the Ps will be high so that it seems impossible to death. But in the peers review process, it is not surprised to find that the patient died. It is clear that predicting the chance of survival using TRISS method alone is unreliable in these situations.

From the analysis of this study, based on TRISS  $> 0.8$  alone, 46 out of 176 patients (26.14 %) were considered to have a chance of survival when they arrived at the hospital. But when considered together with GCS, their chance of survival was reduced to 7 patients (3.98%) only. Of these 7 patients, peer review committees considered that 6 patients had high possibility of death. The only patient that TRISS, GCS

and peer review study were in agreement to suggest a good chance of survival was the case of epidural hematoma who actually failed to survive because of delayed surgery.

There are many factors that TRISS has many flaws in prediction the probability of survival.

First, pre-existing medical conditions is not included in TRISS.<sup>30</sup>

Second, TRISS is derived from part of RTS which is also derived from GCS.<sup>37,38</sup> The main drawback of GCS is that intubation precludes reliable assessment of the verbal score upon arrival at the hospital. Patients with intubation will have lower GCS as compared with ones without intubation; even they have the same trauma conditions. So the patient with intubation will be accounted for poorly. Respiratory rate and verbal response are not accurately obtained in this group.<sup>39,40</sup>

Third, TRISS cannot distinguish between two patients of similar age, anatomic injury, vital sign, and type of injury but present with different timing after injury. The patient who presents shortly after injury has different Ps to the one who presents several hours beyond injury. The problem is that the ability to detect physiologic derangement after injury is time dependent.<sup>39,40</sup> Patients may not manifest physiologic changes immediately after the impact. This is especially true in young, and previously healthy adults. They have greater ability to compensate the body themselves and mask the true extent of injury initially. For instance, rising of intracranial pressure in young and healthy adult may present no abnormality in the compensated GCS status. But at the point of decompensation, pressures change rapidly and compromise brainstem function. This is especially true in case of infratentorial hematoma in which the intracranial pressure changes more rapidly despite the small increment of blood clots.

Fourth, TRISS depicts only the probability of survival regardless of additional resource utilization factors such as cost and duration of admission.<sup>22,23</sup>

Fifth, TRISS does not concern in the outcome of the patients. It points out only the chance of survival regardless of the outcome quality of patients. To say simply, only quantitative but not qualitative is considered.

Sixth, there are many neurotrauma patients who seem to have a greater chance of survival (high Ps) when obtained by TRISS method, but have a less

chance and worst prognosis with multidisciplinary peer review process. This is clear when evaluated with radiological examination such as computed tomography of the brain. The study by Fallon and his colleagues<sup>41</sup> supported this notion. They concluded that peer review process by experienced traumatologists in that field may outperform and more effective than computer-generated TRISS method. There were also many reports that showed the lack of correlation with peer reviewed assessment of unexpected death compared to TRISS method.

Seventh, hence it derived from ISS, it is unable to account for multiple severe injuries to a single body part, head and neck including brain for instance.<sup>10,11</sup> In case of traffic accident especially in the highway with high speed driving, victims may have brain contusion, brain edema, together with cervical spine fracture or dislocation. According to ISS, these patients will fall in only I category of BRI (as of ISS), despite the cervical spine fracture may endanger the brain oxygenation leading to increased severity.

Eighth, TRISS does not distinguish between the sizes, mass effect, duration of neurologic impairment and duration of time since injury but different mechanism. For example, the patients with epidural hematomas tend to do well after evacuation of hematoma, whereas those with subdural hematomas have poorer outcomes. In subdural hematoma, there is usually coexisting damage to the underlying brain parenchyma.

Thus, TRISS model did not correlate well in predicting survival for neurotrauma patients. Some possible refinements such as the mechanisms of injury, timing of injury, nature of diseases, hospital charges, and the prognosis should be included in the models in predicting the neurotrauma outcome. Recent studies by Rutledge and coworkers claimed that ICISS is a better indicator of survival that outperforms TRISS as an indicator in injury severity grading, quality assessment, improvement effort and of resource utilization. ICISS may be a new model in predicting such outcome more precisely. Further studies are needed to further support that ICISS methodology is an accurate predictor of survival in neurotrauma patients.

## CONCLUSION

In conclusion, the major drawbacks of TRISS are

obviously addressed and pointed out by data from several recent papers and in this study. TRISS method is not accurate as a predictor of the chance of survival in head-injured patient group.

Until now, there is no infallible method of scoring in predicting the outcome and chance of survival in head-injured patients and they should never intend to replace the individual judgement by neurosurgeons themselves. The data from Rutledge and coworkers suggesting that ICISS may be a better indicator of survival that outperforms TRISS as an accurate predictor of survival in neurotrauma patients requires further studies to support.

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# Preoperative Serum Albumin Level and Postoperative Septic Complications

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## Abstract

**Objective:** To determine whether preoperative serum albumin level is significantly related to postoperative infectious and wound healing complications, after having adjusted for other risk factors.

**Materials and Methods:** Medical records of patients undergoing major abdominal operations, who were without predisposing conditions for infection or existing infections, and were not given total parenteral nutrition (TPN) were reviewed. Data from 140 patients in the period 1997 to 1998 were analyzed to study the association between risk factors (preoperative serum albumin, age, sex, ASA class, operative time, and body weight), and postoperative septic complications (wound dehiscence, wound infection, pneumonia, anastomotic leakage, sepsis, and intra-abdominal collection).

**Results:** Only low serum albumin level (less than 3.0 gm/dl) and ASA class were significantly related to postoperative septic complications (odds ratio: 8.21; 95% CI: 3.21 - 21.00 and odds ratio: 2.56; 95% CI: 1.35 - 4.88, respectively).

**Conclusion:** The results of this study suggest that preoperative serum albumin level in patients without certain comorbid diseases is associated with postoperative infectious and surgical complications. Low serum albumin level can be used as a marker for nutritional deficiency, and TPN as nutritional supplement in certain subset of patients may reduce postoperative septic complications. Among other risk factors examined, only the ASA class was also significantly related to postoperative septic complications.

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Various studies in the past have noted that low preoperative serum albumin level is significantly related to postoperative septic morbidity and mortality, for many major surgical procedures.<sup>1-10</sup> In a recent review of the experience in esophageal anastomotic leakage conducted at our institution, low preoperative albumin level was found not to be significantly associated with leakage. However, most of these patients were given aggressive preoperative nutritional support, which may confound the association between (pretreatment) serum albumin level and anastomotic leakage. Stimulated by this finding, we reviewed the charts of our general surgical patients who underwent major abdominal operations, exclusive of esophageal surgery, at roughly the same time period. The objective of the study was to more clearly define the relationship

between preoperative serum albumin level and postoperative septic complications at our institution.

## MATERIALS AND METHODS

We reviewed the medical records of patients admitted to the general surgical service at our institution, on whom major abdominal operations were performed during the one-year period between January 1997 and January 1998. The inclusion criteria were adult patients undergoing opened abdominal operations (Table 1). Patients with any form of preoperative infections patients with underlying diabetes mellitus, patients taking corticosteroids for any length of time, patients with advanced cancer (stage IV disease), and patients receiving preoperative

**Table 1** Major abdominal operations performed

Operation	Number of patients (%)
Colonic resection, colostomy and anastomosis	49/140 (35)
Biliary tract operations (CBD exploration; hepatico-/cholecho- jejunostomy/duodenostomy; cholecystectomy)	42/140 (30)
Gastric resection and gastrojejunostomy	20/140 (14)
Exploratory laparotomy and adhesiolysis	9/140 (6)
Pancreatoduodenectomy	7/140 (5)
Hepatectomy	5/140 (4)
Miscellaneous (porto-systemic shunt; abdominal tumour removal; adrenalectomy; pancreatic cystojejunostomy; distal pancreatectomy)	8/140 (6)

total parenteral nutrition (TPN) were excluded. There were 140 patients for whom the records were sufficiently complete for analysis. The records were studied for preoperative serum albumin level obtained within one week before operation, and for other potential risk factors of operative morbidity: age, sex, American Society of Anesthesiologists (ASA) class, operative time, and body weight. The outcomes of postoperative infectious and wound healing complications (collectively defined as postoperative septic complications): pneumonia, wound infection and dehiscence, anastomotic leakage, sepsis, and intra-abdominal collection (Table 2). All the above potential risk factors were simultaneously analyzed for significant association with postoperative morbidity using multiple logistic regression in a backward stepwise manner.<sup>11</sup> Two-sided p-values of 0.05 or less were considered statistically significant. Results were reported as odds ratios and 95% confidence intervals (95% CI), along with 2-sided p-values. All statistical analyses were done using STATA v.7 statistical software.

## RESULTS

The risk factors for postoperative septic complications are presented in Table 3 for those with and without complications. There were 32/140 (23%) patients with postoperative septic complications in this series. Low serum albumin level (categorized as less than 3.0 gm%, or otherwise) and ASA class were significantly related to postoperative septic complications on univariable analysis by chi-square test.

**Table 2** Septic complications: definitions and frequencies

Complications	Number of patients (%)
Wound infection: gross purulence	14/140 (10)
Wound dehiscence: obvious wound disruption	3/140 (2.1)
Anastomotic leakage: operative or radiologic findings	4/140 (2.9)
Intra-abdominal collection: operative or radiologic findings	3/140 (2.1)
Pneumonia: positive clinical, radiologic, or sputum culture	8/140 (5.7)
Sepsis : clinical manifestations of sepsis with sources besides those mentioned above, and positive hemoculture	7/140 (5)
Overall number of patients with complications	32/140 (22.9)

On backward stepwise multiple logistic regression essentially the same conclusion was reached. The odds ratios and 95% CI's for the final model are presented in Table 4. When preoperative serum albumin level was less than 3.0 gm% the patient would have an 8-fold odds (here equivalent to a 5-fold risk) of postoperative septic complications, relative to the patient with a level of 3.0 gm/dl or higher. ASA class was linearly related to postoperative infectious and wound healing complications in the logistic model, with a 2.5 fold increase in the odds of complications (or 2.2 fold increase in the risk) for each increase in the ASA category. Preoperative serum albumin level was a better predictor of postoperative septic complications than the ASA class as can be seen by the area under the Receiver Operating Characteristic (ROC) curve (also called c-index1) of 0.72 for serum albumin level vs. 0.65 for ASA class.

A secondary analysis was performed for the outcome "surgical septic complications" defined as wound infection, wound dehiscence, anastomotic leakage, or intraabdominal collection. There were 21/140 (15%) patients with surgical complications. Interestingly, the only risk factor significantly related to this group of complications, out of the 6 factors studied, was preoperative serum albumin level less than 3.0 gm%. ASA class was not significantly related to this outcome. The odds ratio (95% CI) for serum albumin level less than 3.0 gm/dl was 3.13 (1.17-8.31), or around 3-fold risk of surgical complications, somewhat lower than the 5-fold risk for all septic complications.

**Table 3** Risk factors for postoperative septic complications

Risk factors	Patients without complications n = 108	Patients with complications n = 32
Serum albumin level < 30 gm/dl: yes (%)*	14 / 108 (13.0)	18 / 32 (56.3)
Sex: male (%)	56 / 108 (51.9)	18 / 32 (56.3)
Age: years (mean ± sd.)	54.8 ± 15.8	57.6 ± 16.4
Body weight: kg (mean ± sd.)	55.5 ± 12.3	53.8 ± 15.0
Operative time >3 hours: yes (%)	42 / 108 (38.9)	13 / 32 (40.6)
ASA class*:		
1: no. (%)	25 / 108 (23.2)	4 / 32 (12.5)
2: no. (%)	67 / 108 (62.0)	15 / 32 (46.9)
3: no. (%)	16 / 108 (14.8)	9 / 32 (28.1)
4: no. (%)	0	4 / 32 (12.5)

\*Significantly different between groups at 5% level by chi-squared test

## DISCUSSION

Preoperative serum albumin level has been well documented to have significant association with postoperative infectious and wound healing complications for a wide variety of surgical settings.<sup>1-10</sup> A recent large-scale prospective cohort study (the VA surgical risk study<sup>1</sup>) confirmed this relationship, but the association was strongest for infectious complications.<sup>1,9</sup> We undertook this retrospective study on a group of general surgical patients without known comorbidities predisposing postoperative infections to see whether the same association holds for our patients. The study was partly stimulated by the finding of our previous retrospective study that low preoperative serum albumin level was not related to esophageal anastomotic leakage, contrary to expectations.<sup>7,8</sup> It was thought best not to focus on any specific group of surgical patients, to broaden the generalization of our data. Our results revealed that the condition associated with low preoperative serum albumin level was a significant risk for postoperative infectious and wound complications, as would be expected. This risk was, as with the VA surgical risk study, higher when all infectious complications were included than when wound complications alone were considered. Also, it is perhaps not surprising that ASA class was significantly related to the same outcome since other major studies obtained similar results.<sup>1,2</sup>

Several reports found preoperative serum albumin level to be a poor predictor of postoperative complications.<sup>12-14</sup> There may be various to account for this

**Table 4** Significant risk factors for postoperative septic complications

Risk factors	Odds Ratio (95% CI)	p-value
Serum albumin < 3.0 gm/dl	8.21 (3.21 - 21.00)	<0.01
ASA class*	2.56 (1.35 - 4.88)	<0.01

\*OR is per "unit" increase in ASA class (e.g., from class 2 to class 3)

lack of association. TPN administration prior to surgery effective altered the nutritional status of the patient. Thus, preoperative serum albumin levels determined prior to TPN administration, no longer reflected the true nutritional status of the patient. In this study only patients not given TPN were eligible for inclusion, thus avoiding the masking effects of TPN.

In one study of 221 patients undergoing cardiac surgery,<sup>12</sup> serum prealbumin, as well as other nutritional protein markers such as serum transferrin and retinol binding protein, were found not to be significantly related to sternotomy wound infection. Although serum prealbumin was used in the study, it has a similar, role as serum albumin in predicting postoperative wound complications.<sup>15</sup> They encountered only 6 sternal wound infections (2.7%) in the whole series. In two other studies, one conducted on a cohort of 302 general surgical patients<sup>13</sup> and the other on 170 patients undergoing primary hip or knee prosthesis surgery,<sup>14</sup> the lack of association between preoperative serum albumin level and postoperative wound and infectious complications could be explained by the fact that most of these patients were well nourished preoperatively. Both studies reported on average

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preoperative serum albumin levels above 4 gm/dl, and in one study only 11 per cent of patients had levels below 3.5 gm/dl. In contrast, in the VA surgical risk factors study,<sup>1</sup> 23 per cent of their patients had preoperative albumin level below 3.5 gm/dl and in the current study 23 per cent of patients had levels below 3.0 gm/dl.

A common reason invoked to explain the association between serum albumin level and postoperative septic complications is that serum albumin is a marker for circulating visceral protein,<sup>16,17</sup> a direct measure of nutritional and immunological status. Serum albumin itself may not be one of the essential components in the wound healing process, since analbuminemic patients can have normal wound healing.<sup>18</sup> This may be true in most clinical situations, but in a recent study of 2,745 cardiac surgical patients admitted to a cardiovascular intensive care unit, postoperative complications were not associated with preoperative hypoalbuminemia (serum albumin less than 3.5 gm/dl) alone or in combination with other malnutrition markers (body mass index less than 20 kg/m<sup>2</sup>), but rather were associated with hypoalbuminemia in combination with liver dysfunction or in combination with cardiac failure.<sup>19</sup> If true, then this finding, at least for cardiac surgical patients, may imply that other conditions besides malnutrition may underlie the association between hypoalbuminemia and postoperative complications.

Although our findings demonstrated that low preoperative serum albumin level was associated with increased postoperative infectious and wound complications, several critical points may be worth mentioning. Since this is a retrospective study, our selection of patients for whom the records were complete could introduce a selection bias, even there was no indication that the excluded patients were different from the ones studied. Our set of risk factors may have excluded important variables which could "explain" the relationship between serum albumin level and postoperative septic complications. We have attempted to avoid this problem by excluding patients with previously known comorbid conditions associated with septic complications. A more comprehensive list of surgical risk factors can be found in the VA surgical risk study.<sup>1</sup> Finally, our definitions of the risk factors and postoperative complications may not be sufficiently precise, leading to measurement bias.

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# *The Accuracy of Predictive Parameters for The Presence of Common Bile Duct Stones*

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## **Abstract**

**Background:** Common bile duct stones (CBD stones) are the most common cause of obstructive jaundice and cholangitis. Many technological refinements have been made in radiology, endoscopy and clinical laboratory testing that improve the diagnosis and evaluation of patients with CBD stones. This study was designed to determine the accuracy of the predictive parameters for preoperative diagnosis of CBD stones.

**Methods:** From January 1997 to September 2002, the data of 244 patients who underwent preoperative ERCP with a high index of suspicion for CBD stones based on clinical, biochemical and ultrasonographic criteria were evaluated.

**Results:** A raised serum alkaline phosphatase level was found to be of highest sensitivity (87%) but of low specificity (26%) indicator for CBD stones. Ultrasonography yielded the highest specificity (92%), the positive predictive value was 85 per cent and likelihood ratio positive of 6.48 for CBD stone. The combination of a raised serum alkaline phosphatase and dilated CBD on ultrasonography increased sensitivity to 91 per cent. The combination of finding CBD stone on ultrasonography and pancreatitis increased the specificity to 99 per cent for predicting presence of CBD stone.

**Conclusions:** A raised serum alkaline phosphatase level, CBD stone finding on ultrasonography, dilated CBD on ultrasonography and pancreatitis could be used as criteria for selective preoperative ERCP or cholangiogram in patient undergoing cholecystectomy.

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Choledocholithiasis or common bile duct (CBD) stones is the most common cause of obstructive jaundice and cholangitis.<sup>1-1</sup> In many patients, the stones may also be associated with pancreatitis.<sup>3,6</sup> Approximately 11-18 per cent of patients with gallstones will have associated CBD stones at the time of operation. In the last decade, many technological refinements have been made in radiology, endoscopy and clinical laboratory testing that improve the diagnosis and evaluation of patients with CBD stones.<sup>7-9</sup>

In most patients with CBD stones, the serum alkaline phosphatase will be elevated along with the serum gamma glutamyl transpeptidase (GGTP). These tests are among the most sensitive laboratory indicators of biliary obstruction and may be elevated even when the total bilirubin remains in the normal range.<sup>7-9</sup> Patients with fully developed obstruction will show elevations of alkaline phosphatase, GGTP, and bilirubin. Often alanine aminotransferase (ALT) and aspartate aminotransferase (AST) levels are mildly

elevated in longer standing obstruction and markedly elevated in associated cholangitis. Abdominal ultrasound examination is the preferred first imaging study in most patients in whom biliary tract obstruction is suspected. When biliary tract dilatation has been demonstrated by ultrasound, the clinician must consider the next imaging study, in most cases, a cholangiogram.<sup>10-13</sup> The preferred types of cholangiograms in most medical centers today is the endoscopic retrograde cholangiopancreatogram (ERCP) done by surgical or medical endoscopists. A widely adopted policy is to subject patients considered to be at high risk of CBD stones to preoperative ERCP. The criteria for ERCP were based on recognized clinical, biochemical and ultrasonographic abnormalities.<sup>14-16</sup> Using these criteria, bile duct stones may be positively identified at ERCP in only 10-60 per cent of cases. Consequently, a large number of patients would undergo unnecessary ERCP with an attendant potential for morbidity and poor cost-effectiveness.

The purpose of this study is to evaluate the accuracy of clinical presentation, liver function tests, and abnormal ultrasonographic findings as predictor criteria in CBD stone detection. The sensitivity and specificity of these criteria may thereby be used to rationalize the need for preoperative ERCP in patients undergoing cholecystectomy.

## MATERIALS AND METHODS

This study was carried out in the Division of General Surgery, Department of Surgery, Bangkok Metropolitan Administration Medical College and Vajira Hospital. Eligible patients were those with signs and symptoms of biliary obstruction seen between January 1997 and September 2002. Age, sex, detailed history regarding episodes of jaundice, acute pancreatitis or acute cholangitis were recorded. Liver function tests (bilirubin, aspartate aminotransferase, alanine aminotransferase and alkaline phosphatase levels) and ultrasonographic findings were determined. Biochemical investigations at presentation were considered abnormal when the serum bilirubin level was more than 1.0 mg/dl, serum alkaline phosphatase concentration exceeding 279 U/L, serum aspartate aminotransferase level more than 40 U/L, and serum alanine aminotransferase level more than 35 U/L. Ultrasonographic criteria used for suspecting

common bile duct stone were the visualization of sonographic features of a CBD stone, presence of bile duct dilatation or CBD size greater than 7 mm.

Preoperative Endoscopic Retrograde Cholangio-Pancreatography (ERCP) was performed in patients with a high index of suspicion for CBD stones based on clinical, biochemical and ultrasonographic criteria. All investigations were performed within 2 weeks prior to ERCP.

The techniques of ERCP is the standard maneuver. The patient initially lays on lateral position and sedated with diazepam 5-10 mgs intravenously. After the side-viewing endoscope has been passed through the pylorus into the duodenal bulb, and corkscrewing the endoscope around the superior duodenal angle, then the patient is turned to prone position. Intermittent intravenous boluses of hyoscine-N-butyl bromide 10 mgs are administered to induce and maintain duodenal paralysis. When the papilla is successfully cannulated, contrast is injected under radiologic control. Attention to radiologic technique is crucial because diagnostic information is only as good as the quality of the images obtained. The patients found to have CBD stones were subject to endoscopic sphincterotomy.

The findings at ERCP and/or stone retrieval were taken as the 'gold standard' for evaluating the predictive value of each parameter.

The results were analysed by calculating the sensitivity, specificity, positive and negative predictive values, prevalence rate and likelihood ratio of each criterion.

Statistical analysis was done using Microsoft Excel 2000 for calculating evaluative indices with 95% confidence interval (CI).

## RESULTS

A total of 244 patients, 102 men (42%) and 142 women (58%) were evaluated. The mean age of the patient was 55 years (28-71). The clinical characteristics and results of investigations in patients with and without common bile duct stones are presented in Table 1.

Clinical jaundice was detected in 124 patients of whom 76 were found to have common bile duct stones. Of 73 patients with acute ascending cholangitis, only 28 had common bile duct stones and of 35 patients with acute pancreatitis, only 5 had common



**Table 1** Clinical and investigative findings in 244 patients with and without common bile duct stones.

Parameter	No. of patients	Percentage
Age (years)		
< 55	107	43.85
≥ 55	137	56.15
Sex		
Male	102	41.80
Female	142	58.20
Jaundice		
Absent	120	49.18
Present	124	50.82
Ascending cholangitis		
Absent	171	70.08
Present	73	29.92
Pancreatitis		
Absent	209	85.66
Present	35	14.34
Alkaline phosphatase level		
Normal	49	20.08
Greater than normal	195	79.92
Bilirubin level		
Normal	108	44.26
Greater than normal	136	55.74
Aspartate aminotransferase level (AST)		
Normal	104	42.62
Greater than normal	140	57.38
Alanine aminotransferase level (ALT)		
Normal	93	38.11
Greater than normal	151	61.89
Duct diameter on ultrasonography		
Normal	100	40.98
Dilated	144	59.02
CBD stone features on ultrasonography		
Absent	179	73.36
Present	65	26.64

bile duct stones.

A raised serum alkaline phosphatase level above normal was found to be a highest sensitivity indicator (87%) of common bile duct stones although its specificity was low (26%). A raised serum bilirubin level above normal yielded intermediate sensitivity (68%) and specificity (55%).

Serum aspartate aminotransferase level greater than normal was found to have low sensitivity (57%) and low specificity (42%), and similarly the serum alanine aminotransferase level greater than normal had low sensitivity (63%) and low specificity (39%).

A dilated bile duct on ultrasonography was second to a raised serum alkaline phosphatase in predicting the presence of CBD stones, the sensitivity was 80 per

cent but specificity was only 59 per cent. Ultrasonography predicted stones in 65 of 244 patients yielding highest specificity (92%) but low sensitivity (49%). The positive predictive value of ultrasonography in detecting common bile duct stone was the highest among parameters (85%) with a likelihood ratio positive of 6.48 (Table 2).

The sensitivities and specificities of any two combined parameters in predicting presence of common bile duct stones are shown in Table 3. Combination of a raised serum alkaline phosphatase and dilated CBD on ultrasonography increased the sensitivity to 91 per cent but with the specificity of only 35 per cent. However, combinations of suspected CBD stone feature on ultrasonography and pancreatitis increased specificity to 99 per cent but having sensitivity of only 12 per cent.

## DISCUSSION

This study highlights the difficulty of attempting to accurately identify CBD stones before operation. The commonly used predictors of common bile duct stones are jaundice, ascending cholangitis or acute pancreatitis, abnormal liver biochemistry and ultrasonographic suspicion of choledocholithiasis.<sup>7,17,18</sup> The criteria for selection of patients for ERCP or cholangiography have to be stringent. The parameters must be sensitive enough to prevent missing patients with common bile duct stones, and must also have a high positive predictive value so that many unnecessary ERCP or cholangiograms are not performed.<sup>8,10-12,14-16</sup>

Several studies tried to improve the accuracy of diagnosis of CBD stones by assessment of clinical, biochemical and ultrasonographic criteria, with variable results. Barkun et al<sup>18</sup> generated a predictive model for selecting patients for preoperative ERCP. Using logistic regression, the best model for predicting common bile duct stones at ERCP included the following independent predictors: age over 55 years, raised bilirubin concentration, CBD dilatation and a CBD stone finding on ultrasonography. The probability of finding ductal stones at ERCP ranged from 8 per cent when none of these predictors was present to 94 per cent when all four were present.

Abboud et al<sup>9</sup> examined numerous indicators for their ability to predict the presence of CBD stones in patients with symptomatic gallstones. Their findings

**Table 2** Results of different parameters in predicting the presence of common bile duct stones

Parameter	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)	PV (95% CI)	LR
Jaundice	0.61 (0.52 - 0.70)	0.58 (0.49 - 0.66)	0.55 (0.46 - 0.64)	0.63 (0.57 - 0.69)	0.46 (0.40 - 0.52)	+1.43
Ascending cholangitis	0.38 (0.29 - 0.47)	0.77 (0.70 - 0.84)	0.59 (0.48 - 0.70)	0.60 (0.53 - 0.66)	0.46 (0.40 - 0.52)	+1.69
Pancreatitis	0.12 (0.06 - 0.18)	0.83 (0.77 - 0.90)	0.37 (0.21 - 0.53)	0.53 (0.46 - 0.59)	0.46 (0.40 - 0.52)	+0.70
Alkaline phosphatase level greater than normal	0.87 (0.80 - 0.93)	0.26 (0.18 - 0.33)	0.50 (0.43 - 0.57)	0.69 (0.64 - 0.75)	0.46 (0.40 - 0.52)	+1.17
Bilirubin level greater than normal	0.68 (0.59 - 0.77)	0.55 (0.46 - 0.63)	0.56 (0.48 - 0.64)	0.67 (0.61 - 0.73)	0.46 (0.40 - 0.52)	+1.49
Aspartate aminotransferase (AST) level greater than normal	0.57 (0.48 - 0.66)	0.42 (0.34 - 0.51)	0.46 (0.37 - 0.54)	0.54 (0.48 - 0.60)	0.46 (0.40 - 0.52)	+0.99
Alanine aminotransferase (ALT) level greater than normal	0.63 (0.54 - 0.72)	0.39 (0.31 - 0.48)	0.47 (0.39 - 0.55)	0.56 (0.50 - 0.62)	0.46 (0.40 - 0.52)	+1.05
Dilated CBD on ultrasonography > 7 mm	0.80 (0.73 - 0.88)	0.59 (0.51 - 0.67)	0.63 (0.55 - 0.70)	0.78 (0.73 - 0.83)	0.46 (0.40 - 0.52)	+1.96
CBD stone features on ultrasonography	0.49 (0.40 - 0.58)	0.92 (0.88 - 0.97)	0.85 (0.76 - 0.93)	0.68 (0.62 - 0.74)	0.46 (0.40 - 0.52)	+6.48

CI = confidence interval ; PPV = positive predictive value ; NPV = negative predictive value ; PV = prevalence ; LR = likelihood ratio.

**Table 3** Sensitivity (upper, right) and specificity (in italics, lower, left) of a single positive result in any combination of two parameters in detection of common bile duct stones (Estimate and 95% Confidence Intervals)

	Sensitivity								
	JD	Cho	Pan	ALP	Bili	AST	ALT	D.CBD	S.CBD
<b>JD</b>		0.49 (0.38-0.61)	0.14 (0.04-0.24)	0.84 (0.75-0.92)	0.70 (0.60-0.79)	0.64 (0.53-0.74)	0.68 (0.57-0.79)	0.82 (0.73-0.91)	0.58 (0.46-0.70)
<b>Cho</b>	<i>0.75</i> (0.66-0.84)		0.09 (0.02-0.16)	0.76 (0.65-0.87)	0.56 (0.43-0.68)	0.44 (0.32-0.56)	0.62 (0.49-0.75)	0.69 (0.57-0.81)	0.43 (0.30-0.56)
<b>Pan</b>	<i>0.86</i> (0.79-0.94)	<i>0.93</i> (0.88-0.99)		0.21 (0.11-0.32)	0.20 (0.09-0.32)	0.19 (0.08-0.30)	0.26 (0.13-0.39)	0.46 (0.27-0.65)	0.12 (0.04-0.20)
<b>ALP</b>	<i>0.36</i> (0.25-0.47)	<i>0.53</i> (0.41-0.66)	<i>0.72</i> (0.62-0.83)		0.84 (0.77-0.92)	0.85 (0.76-0.93)	0.86 (0.78-0.94)	0.91 (0.85-0.97)	0.84 (0.75-0.94)
<b>Bili</b>	<i>0.58</i> (0.48-0.67)	<i>0.73</i> (0.64-0.82)	<i>0.83</i> (0.73-0.92)	<i>0.33</i> (0.23-0.44)		0.68 (0.57-0.78)	0.72 (0.62-0.82)	0.86 (0.78-0.93)	0.67 (0.54-0.79)
<b>AST</b>	<i>0.50</i> (0.40-0.60)	<i>0.81</i> (0.74-0.88)	<i>0.74</i> (0.63-0.85)	<i>0.28</i> (0.19-0.37)	<i>0.48</i> (0.38-0.58)		0.63 (0.53-0.73)	0.81 (0.72-0.90)	0.57 (0.43-0.72)
<b>ALT</b>	<i>0.48</i> (0.37-0.58)	<i>0.75</i> (0.66-0.84)	<i>0.75</i> (0.63-0.86)	<i>0.25</i> (0.16-0.34)	<i>0.46</i> (0.35-0.56)	<i>0.39</i> (0.31-0.48)		0.87 (0.78-0.95)	0.63 (0.50-0.77)
<b>D.CBD</b>	<i>0.65</i> (0.54-0.76)	<i>0.79</i> (0.70-0.88)	<i>0.74</i> (0.61-0.87)	<i>0.35</i> (0.23-0.46)	<i>0.63</i> (0.51-0.74)	<i>0.51</i> (0.40-0.63)	<i>0.49</i> (0.37-0.60)		0.73 (0.63-0.84)
<b>S.CBD</b>	<i>0.96</i> (0.91-1.00)	<i>0.94</i> (0.88-1.00)	<i>0.99</i> (0.97-1.01)	<i>0.85</i> (0.73-0.97)	<i>0.94</i> (0.89-1.00)	<i>0.93</i> (0.86-1.00)	<i>0.88</i> (0.79-0.96)	<i>0.90</i> (0.84-0.97)	

#### Specificity

CI = confidence interval ; JD = jaundice ; Cho = cholangitis ; Pan = pancreatitis ; ALP = alkaline phosphatase ; Bili = bilirubin ; AST = aspartate aminotransferase ; ALT = alanine aminotransferase ; D.CBD = dilated CBD on ultrasonography ; S. CBD = CBD stone features on ultrasonography.

indicated that several indicators were highly specific. Among these indicators features of CBD stones finding on ultrasonography had the highest specificity (100%), followed by ascending cholangitis, jaundice, dilated CBD on ultrasonography and pancreatitis (specificities of 99, 97, 96 and 95 % respectively). Only elevated bilirubin and alkaline phosphatase yield sensitivities greater than 50 per cent. The sensitivity of elevated bilirubin is 69 per cent and elevated alkaline phosphatase is 57 per cent. In the final analysis, no perfect preoperative predictor of CBD stone has been identified, but the presence of ascending cholangitis, CBD stone finding on ultrasonography or jaundice, are the indicators associated with the greatest discriminatory power (likelihood ratios 18.3, 13.6 and 10.1 respectively).

In this study the indicator that is the most sensitive is elevated serum alkaline phosphatase (sensitivity 87%) but least specific (specificity 26%). The specificity, positive predictive value and likelihood ratios of CBD stone finding on ultrasonography is the highest of all the predictive parameters (specificity 92%, positive predictive value 85% and likelihood ratio positive 6.48). For combination of two predictive parameters, elevated serum alkaline phosphatase and dilated CBD on ultrasonography, yielded the highest sensitivity (91%). The combination of pancreatitis and features of CBD stone on ultrasonography gave the highest specificity (99%). Thus, the statistical data of this study may be used as criteria for selective preoperative ERCP or cholangiogram in patients undergoing cholecystectomy.

### CONCLUSION

Several studies have tried to improve the accuracy of diagnosis of CBD stones by assessment of chemical, biochemical and ultrasonographic criteria with variable results. It is difficult to enable one to identify the presence of CBD stones accurately before operation. To reduce the number of patients undergoing unnecessary ERCP with an attendant potential of morbidity and poor cost-effectiveness, the serum alkaline phosphatase level, CBD stone features on ultrasonography, dilated CBD on ultrasonography and pancreatitis may be used as a guide for selective preoperative ERCP or cholangiogram in patients undergoing cholecystectomy.

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