Impact of comorbidity on outcome among acute non-traumatic surgical patients

Evaluation of Charlson comorbidity index

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ABSTRACT

الأهداف: لتحديد نسبة الإمريضات المرافقة في مرضى الجراحة الإسعافية. ولتقييم تأثير الإمريضات على النتائج، وتقييم مدى فعالية استخدام مؤشر كارلسون (CCI) للإمراضيات المرافقة.

الطريقة: شملت الدراسة جميع مرضى الجراحة العامة (غير الرضية)، واللذين تم قبولهم في مجمع الملك سعود الطبي – الرياض – المملكة العربية السعودية، خلال الفترة مابين يناير 2007م وحتى ديسمبر 2007م. بلغ عدد المرضى 1296 مريضاً، وتم استقصاء وجود الإمراضيات المرافقة لتحديد مؤشر كارلسون (CCI). وتم تقييم نتائج العمل الجراحي على أساس طول بقاء المريض بالمستشفى وحدوث الإختلاطات أو الوفيات بعد الجراحة. كما تمت مقارنة النتائج مع المرضى الذين ليس لديهم المراضيات مرفقة.

النتائج: بلغت نسبة المرضى الذين لديهم إمراضية واحدة أو أكثر 31.9% (414) مريضا، مؤشر كارلسون (CCI) تتراوح مابين 1– 8، وكانت مؤشرات حدوث اختلاطات ووفيات بنسبة أعلى بشكل ملحوظ في المرضى الذين لديهم إمراضيات مرافقة. وكانت مدة البقاء في المستشفى 17.3 يوما مقابل 10.6 أيام – p>0.0001، والاختلاطات بعد العمل الجراحي بلغت 46.3% مقابل 31% – p>0.0001. وبلغت الوفيات 7.7% مقابل 4.4% – p>0.0001. الإمراضيات المرافقة الشديدة حسب مؤشر كارلسون (CCI) أدت إلى مدة بقاء أطول في المستشفى r=0.30 p<0.0001. ونسبة وفيات r=0.2645 - p<0.0001. وبشكل عام نسبة خطورة الوفيات حوالي (1.81) منها لدى المرضى بدون امراضيات مرافقة (OR 1.81, 95%CI 1.087-3.012, p=0.0182).

خاتمة: إن الإمراضيات المرافقة تزيد في مدة بقاء المريض بالمستشفى، ونسبة الاختلاط بعد العمل الجراحي، والوفيات لدى المرضى الذين يخضعون للجراحة الإسعافية غير الرضية. ويعتبر مؤشر كارلسون (CCI) للإمراضيات مفيداً ويمكن الاعتماد عليه في تدبير مرضى الجراحة ذو الخطورة العالية.

Objectives: To determine the prevalence of comorbid conditions among acute non-traumatic general surgery patients. To assess the impact of comorbidity on outcomes and evaluate the effectiveness of using Charlson comorbidity index (CCI) in these patients.

Methods: All acute non-traumatic general surgery patients admitted to King Saud Medical Complex, Riyadh, Saudi Arabia, between January 1, 2007 and December 31, 2007 were included (n=1296). Patient data were explored to record comorbidity, and the CCI score calculated. The length of hospital stay, post-operative complications and mortality were recorded as outcome measures. The outcomes in patients with comorbid conditions were compared with patients without comorbid conditions.

Results: We found one or more comorbid conditions in 31.9% (n=414) patients. The CCI score ranged from 1-8. All 3 outcome measures were recorded significantly higher in patients with comorbidity compared to patients with no comorbid condition; length of stay, 17.3 versus 10.6 days (p<0.0001), post-operative complications 46.3% versus 31% (p<0.0001), mortality 7.7% versus 4.4% (p<0.0001). Severe comorbidity as indicated by higher CCI score significantly correlated with length of stay, r=0.30 (p<0.0001) and mortality, r=0.2645 (p<0.0001). Overall risk of mortality was 1.81 times higher with comorbidity (odds ratio 1.81, 95% confidence interval 1.087-3.012, p=0.0182).

Conclusion: Comorbidity caused increased hospital stay, post-operative complications, and mortality among acute non-traumatic general surgery patients. The CCI is a reliable comorbidity index, which can help in managing risks in surgical patients.

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A growing prevalence of comorbidity is being observed among acute surgical patients. The management of these patients is more demanding requiring active surgical treatment on one hand, and optimization of all related medical illnesses before subjecting them to anesthesia and surgery. With increasing recognition of the relationship between comorbidity and mortality, accurate identification of comorbidity is essential in assessing patient's health status, and quantifying risk of mortality and morbidity. Several methodologies have been developed that weigh the effect of comorbidity on patient prognosis. The Charlson comorbidity index (CCI) is considered reliable among multiple comorbidity indices available.[1,2] The CCI was developed in 1987, based on one-year mortality data from internal medicine patients admitted to a single New York Hospital, and was initially validated within a cohort of breast cancer patients. The index encompasses 19 medical conditions weighted 1-6, with total scores ranging from 0-37. Coronary artery disease, congestive heart failure, chronic pulmonary disease, peptic ulcer disease, peripheral vascular disease, mild liver disease, cerebrovascular disease, connective tissue disease, diabetes, and dementia are all assigned a score of one in this index. Hemiplegia, moderate to severe renal disease, diabetes with end organ damage, any prior tumour, leukemia, and lymphoma have a score of 2, while moderate, or severe liver disease is given a score of 3. Metastatic solid tumor and AIDS have a score of 6. The scores of all the comorbid conditions are added to calculate the CCI.[3] Although CCI was derived using a population of medical patients,[3] it has proven to be a valid predictor of mortality in a number of populations including critically ill,[4,5] and trauma patients.[6] However, there is limited data available regarding prevalence of comorbidity among acute non-traumatic surgical patients. The aim of the study is to determine the prevalence of comorbidity and evaluate its impact in these patients while exploring the usefulness of CCI.

Methods. The study design was a retrospective analysis of patient data. Study approval was obtained from the Hospital Research and Ethics Committee, King Saud Medical Complex. We reviewed the medical records of 1296 consecutive acute non-traumatic surgical patients admitted in the General Surgical Unit at King Saud Medical Complex between January 1, 2007 and December 31, 2007. All patients who were operated upon or treated conservatively were included. A study proForma was developed to record the comorbidity present in each patient based on the original CCI and weighted score calculated (**Table 1**). A patient was considered to have a comorbid condition if the listed disorder were mentioned in the patient's record, or if the patient were treated for it. The length of hospital stay (LOS), post-operative complications, and mortality were recorded as outcome measures. The LOS was calculated as the difference, in days, between date of discharge and date of admission. Complications occurring during post-operative hospital stay were recorded. Mortality was defined as death occurring during the same hospital stay.

The Fisher exact test was used to analyze the categorical data. Continuous variables were analyzed using student's t test. The CCI, LOS, and mortality were analyzed for correlation. Odds ratio (OR) and its 95% confidence interval (CI) was used to assess risk in relation to comorbidity. Statistical Package for Social Sciences for Windows (Version 12.0, SPSS Inc., Chicago, IL) was used for all analyses, and a p-value of <0.05 was considered significant.

Results. Among 1296 patients, 752 (58%) were men. The mean (range) age of the patients was 59 (14-100) years. Eight hundred and eighty-two patients had no comorbid condition (68.05%) compared to 414 (31.95%) with comorbid conditions. Half of the patients with comorbidity had only one comorbid condition, while the rest had more than one comorbid conditions. Diabetes mellitus, chronic pulmonary disease, renal disease, and coronary artery disease were common prevalent comorbidities, while AIDS was the least comorbid condition found in the study group (**Table 2**). The CCI score ranged from 1-8 with most patients having a score of 6 or less, and only 6 patients with higher score. Half the patients had CCI of one and only 0.49% had a CCI of 9 (**Table 3**). The mean LOS was significantly longer among patients with comorbid conditions than patients with no comorbid condition: 17.3 days (range 1-78) compared to 10.6 (range 1-62) ($p<0.0001$). The LOS was highest with CCI score 5 followed by CCI 4 and 6 (**Table 3**). Higher CCI score was positively and significantly correlated with LOS (r= 0.300 which is significant $p<0.0001$). Post-operative complications were more frequent among patients with comorbidity, 46.3% versus 31% ($p<0.0001$). Wound infection, atelectasis, and paralytic ileus were the common post-operative complications. There was a significantly higher frequency of complications of hemorrhage, atelectasis, pneumonia, aspiration pneumonitis, acute respiratory distress syndrome (ARDS), acute renal failure, pulmonary embolism, and cardiac failure among the patients with comorbid conditions. The other complications did not show a significant difference between the 2 groups of patients (**Table 4**). There was a significant difference in mortality between patients with comorbidity (7.7%) and those with no comorbid conditions (4.4%). The comorbidity

Table 1 - Study proForma.

Patients initial/ Age/ Gender: _____	
Hospital No. _____	Unit/ Bed:
Date of admission:	Date of discharge/death: _____
Diagnosis:	
Management	
Score 1	**Score 2**
Coronary artery disease	Hemiplegia
Congestive heart failure	Moderate to severe renal disease
Chronic pulmonary disease	Diabetes with end organ damage
Peptic ulcer disease	Any prior tumor (within 5 years)
Peripheral vascular disease	Leukemia
Mild liver disease	Lymphoma
Cerebrovascular disease	**Score 3**
Connective tissue disease	
Diabetes	Moderate/severe liver disease
Dementia	
	Score 6
	Metastatic solid tumor
	AIDS
Charlson comorbidity index (CCI):	
Post-operative complications: _____	
_____	
Hospital stay: _____ days	
Management outcome:	Discharge / death

Table 2 - Charlson comorbidity index and prevalence of comorbid conditions.

Score	Condition	No. of patients (%)
1	Coronary artery disease*	52 (12.5)
	Congestive heart failure	35 (8.4)
	Chronic pulmonary disease	75 (18.1)
	Peptic ulcer disease	22 (5.3)
	Peripheral vascular disease	23 (5.5)
	Mild liver disease	19 (4.5)
	Cerebrovascular disease	27 (6.5)
	Connective tissue disease	16 (3.8)
	Diabetes	168 (40.5)
2	Dementia	20 (4.8)
	Hemiplegia	18 (4.3)
	Moderate to severe renal disease	65 (15.7)
	Diabetes with end organ damage	53 (12.8)
	Any prior tumor (within 5 years of diagnosis)†	4 (0.009)
3	Leukemia	2 (0.004)
6	Lymphoma	3 (0.007)
	Moderate to severe liver disease	23 (5.5)
	Metastatic solid tumour	3 (0.007)
	AIDS (not only HIV positive)	0 (0)

*Including myocardial infarction, coronary artery bypass graft, percutaneous transluminal coronary angioplasty and angina pectoris, †except basal cell skin carcinoma

Table 3 - Comorbidity and length of hospital stay.

Comorbidity	Length of hospital stay	
Patients with no comorbidity **(n=882)**		
Mean ± SD	10.6* ± 9.78†	
Range	1-62	
Patients with comorbidity **(n=414)**		
Mean ± SD	17.3* ± 15.92†	
Range	1-78	
CCI Score	**Number of patients**	**Mean length of hospital stay**
CCI 1	207	11.1
CCI 2	67	13.5
CCI 3	53	18.2
CCI 4	47	20.4
CCI 5	14	25.5
CCI 6	20	19.0
CCI 7	4	15.5
CCI 8	2	15.2

*p=0.0001 (student's t test), †standard deviation, CCI - Charlson comorbidity index

Table 4 - Post operative complications.

Complications	Patients with no comorbidity (N=274) n (%)	Patients with comorbidity (N=192) n (%)*	*P*-value
Hemorrhage	2 (0.2)	6 (1.6)	0.0155*
Atelectasis	78 (8.8)	21 (5.0)	0.0182*
Pneumonia	7 (0.7)	18 (4.3)	0.0001*
Wound infection	88 (9.9)	45 (10.8)	0.6245
Wound dehiscence	18 (2.0)	8 (1.9)	1.0000
Anastomosis dehiscence	4 (0.4)	5 (1.2)	0.1545
Deep vein thrombosis	4 (0.4)	3 (0.7)	0.6864
Acute urinary retention	5 (0.5)	0 (0)	0.1839
Urinary tract infection	3 (0.3)	3 (0.7)	0.3910
Bowel obstruction	6 (0.6)	3 (0.7)	1.0000
Paralytic ileus	26 (2.9)	17 (4.1)	0.3182
Superficial thrombophlebitis	18 (2.0)	7 (1.6)	0.8293
Abscess formation	8 (0.9)	9 (2.1)	0.0702
Aspiration pneumonitis	3 (0.3)	6 (1.4)	0.0340*
Acute renal failure	4 (0.4)	12 (2.8)	0.0005*
Pulmonary embolism	0 (0)	3 (0.7)	0.0324*
Cardiac failure	0 (0)	9 (2.1)	0.0001*
Acute respiratory distress syndrome	0 (0)	17 (4.1)	0.0001*

*significant p-value (Fisher's exact test, contingency table)

Table 5 - Significant positive statistical correlation between CCI score category and mortality.

Mortality / score	n (%)	OR (95% CI)†
Patients with no morbidity (n=882)	39 (4.42)*	
Patients with comorbidity (n=414)	32 (7.72)*	1.81 (1.087-3.012)*
CCI 1 (n=207)	7 (3.3)	0.75 (0.304-1.795)
CCI 2 (n=67)	2 (2.9)	0.64 (0.105-2.816)
CCI 3 (n=53)	2 (3.7)	0.81 (0.133-3.588)
CCI 4 (n=47)	2 (4.2)	0.92 (0.149-4.066)
CCI 5 (n=14)	4 (28.5)	6.17 (1.631-21.392)*
CCI 6 (n=20)	11 (55)	11.88 (4.941-28.329*
CCI 7 (n=4)	2 (50)	10.80 (1.331-71.593)*
CCI 8 (n=2)	2 (100)	21.61 (2.111-221.64)*

CCI - Charlson comorbidity index, *significant p-value, †odds ratio (95% confidence index)

has significantly higher risk (42.8%) of mortality (OR 1.8, 95% CI 1.087-3.012) (p=0.0182). The mortality increased with a rise in CCI score, being 3.4% at CCI one, and reaching 100% at CCI score 8. The correlation between mortality and CCI score, however, was not statistically significant for patients with CCI score up to 4, but became significant for higher CCI scores. There is a significant positive statistical correlation between higher CCI score category and corresponding mortality, r=0.2645 (p<0.0001) (**Table 5**).

Discussion. The CCI scores have demonstrated prognostic value, both in terms of post-operative complications and survival among a variety of inpatients including malignancy.[7-17] We explore the relationship between CCI scores and post-operative complications. In this study, 31.9% patients had at least one comorbid condition on presentation, and the highest CCI score was 8. Similar comorbidity (33.2%) has been found among patients with major blunt trauma with highest CCI score of 6.[6] Studies show a higher prevalence of comorbidity among cancer patients (70-89%) most likely due to a higher proportion of elderly patients among them.[18] Although the CCI score ranges from 0-37, most of the studies have reported a maximum CCI score of 6-9 with a minority of patients above CCI score 6. In our study, the maximum score was 8, and only 6 patients with a CCI score above 6.

All the comorbid conditions used to calculate CCI were found in patients of this study except AIDS, apparently due to the reason that the number of HIV patients in Saudi Arabia is still limited.[19] Diabetes mellitus was the most frequent comorbid condition found in 221 patients including 53 with end organ damage,

17% of total patients, and 53.3% with comorbidity. The prevalence of diabetes in the study sample is slightly higher than the 12-14% prevalence reported in urban populations in Saudi Arabia.[20] Chronic pulmonary disease (18.1%), renal disease (15.7%), and coronary artery disease (12.5%) were the other common comorbid conditions. A similar prevalence of chronic pulmonary disease (17.2%) has been reported among hospitalized patients with respiratory disorders in Saudi Arabia.[21] The prevalence of renal disease is higher in this study than other comorbid studies, which may be correlated to diabetes. Chronic pulmonary and coronary artery disease was the most common comorbid conditions among cancer cohorts.[15,18,22] The LOS was significantly longer among patients with comorbidity with extensive multidisciplinary management and higher admissions in the intensive care unit (ICU). The LOS in this study increased as CCI scores increased from 0-5. However, LOS decreased in patients with CCI score 6-8, because they were critically ill with severe comorbidity and severe complications leading to earlier mortality. Among the cancer patients, a higher CCI score showed a slight increase of LOS but it was not significant.[18] There was no significant difference in the incidence of common post-operative complications between the 2 groups of patients, showing that these complications are influenced more by the primary surgical disease than the comorbidity. However, the serious and fatal complications were prevalent in comorbid group of patients, similar trends are shown in other studies emphasizing CCI as the best predictor of major complications of surgery.[18]

Overall higher CCI score correlated with higher mortality in this study, comorbidity had a hazard risk of 1.8. However, significantly higher mortality occurred in patients with CCI score of 5 and above compared to patients with no comorbidity; this difference was not significant with lower CCI scores. Trauma patients who had a CCI score of 2 or 3 were correlated with an elevated risk of mortality compared with patients who did not have comorbidities.[6] In nonsurgical emergency department patients, comorbidity has been associated with a hazard ratio of 1.15 (95% CI 1.04-1.28, $p<0.0001$) for 7 day mortality.[23] A comparative study[24] of comorbidity indices among admitted patients with the primary diagnosis of respiratory and circulatory diseases, shows a higher mortality rate as the index increased using original CCI and 2 other indices.[24] Taking into account comorbid conditions significantly added to a model that predicted survival in colonic cancer patients. Risk ratios for total comorbidity were significantly different for 2 highest scores compared with the lowest.[15] The CCI index has also been validated as a prognostic survival indicator in lung and prostate cancer cohorts,[25,26] apart from the original correlation with increased mortality in a breast cancer cohort.[3]

There is limited literature investigating the prevalence of comorbidity in acute non-traumatic surgical patients. Therefore, the data presented here is mostly compared with comorbidity reported in medical, trauma, and cancer patients. The basic limitation of using the CCI score to predict complications is preservation of data only for the 19 conditions listed in the index, and exclusion of diseases like hematological conditions and hypertension. In our study, 7.4% patients had hypertension as the only comorbid condition. Although severe or long-standing hypertension will cause other comorbid conditions in the index, hypertension itself is an important comorbid condition missing from the CCI calculation. The other limitation is that CCI does not take into account the severity of individual comorbid conditions, which may have a direct influence on outcome in addition to the overall CCI score.

In conclusion, the comorbid illness had a significant direct influence on the survival outcome in acute non-traumatic surgical patients. Severity of comorbidity correlated significantly with length of hospital stay, major post-operative complications, and mortality. Our study shows that CCI score, as a measure of comorbid conditions, correlated significantly with morbidity and mortality. Thus, using CCI scores routinely in surgical practice to predict outcome and plan appropriate management may be a useful tool for reducing LOS, post-operative complications, and mortality in non-traumatic surgical patients. Such schemes have already been successfully implemented in other specific conditions, such as Ranson score for pancreatitis, the Child classification of liver failure, and Burns index. Despite its limitations, CCI is a reliable comorbidity index for its ease of use, short rating time, and extrapolation from ICD-9 or ICD-10, and should be incorporated into routine patient management.

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Ethical Consent

All manuscripts reporting the results of experimental investigations involving human subjects should include a statement confirming that informed consent was obtained from each subject or subject's guardian, after receiving approval of the experimental protocol by a local human ethics committee, or institutional review board. When reporting experiments on animals, authors should indicate whether the institutional and national guide for the care and use of laboratory animals was followed.