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Predicting outcomes of acute low back pain patients in emergency department

A prospective observational cohort study

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Abstract

Low back pain (LBP) is a common complaint among patients presenting to emergency department (ED) in Singapore. The STarT Back Screening Tool (SBT) was recently developed and validated for triage of LBP patients in primary care settings. This study aimed to investigate whether the SBT could provide prognostic information for long-term outcomes of acute LBP patients visiting the ED, who might benefit from appropriate and timely management at an earlier stage.

Data were collected in a prospective observational cohort study from 177 patients who consulted emergency physicians for acute LBP and completed 6-month follow-up. Patients were administered the SBT and assessed at baseline. Follow-up assessments were conducted at 6 weeks and 6 months.

A multiple linear regression model incorporating SBT total score, age, employment status, LBP history, and 6-week pain score was constructed to predict 6-month pain score. In the model, SBT total score and 6-week pain score were significantly associated with 6-month pain score ($P < .05$) with respective coefficients of 0.125 and 0.500. The model explained 40.1% of the variance for 6-month pain score.

This study demonstrated that the multiple linear regression model showed predictive performance in determining long-term outcomes for acute LBP patients presenting to the ED.

Abbreviations: BMI = body mass index, CCI = Charlson comorbidity index, CI = confidence interval, ED = emergency department, ICD-9 = International Classification of Diseases 9th Revision, LBP = low back pain, NPRS = numeric pain rating scale, SBT = STarT Back Screening Tool, SD = standard deviation, SGH = Singapore General Hospital.

Keywords: emergency department, low back pain, pain score, STarT Back Screening Tool

1. Introduction

Low back pain (LBP) is a common and challenging health problem affecting up to 84% of adults.[1] The results from the Global Burden of Disease Study 2013 showed that LBP was among the top 10 leading causes of years lived with disability worldwide.[2] Most of the LBP patients recover from initial onset of pain within a few weeks or months, whereas 3% to 25% of patients will develop chronic symptoms.[3,4] This small portion of individuals nonetheless accounts for significantly high medical costs in diagnosis, treatment, and medication, which imposes a huge economic burden to the healthcare system.[5,6] In addition, patients with chronic LBP incur indirect socioeconomic costs particularly in industrialized countries attributable to work absenteeism, loss of work capacity, and reduction of productivity. For example, estimates for indirect costs of LBP are US$70 billion per annum in the United States[7] and €4.1 billion in Switzerland.[8]

It would be clinically and economically advantageous for LBP patients with high risk of poor prognosis to be identified early for prompt and appropriate interventions to reduce the likelihood of chronicity. Recently, some studies have identified useful factors that are associated with future LBP chronicity and disability. A systematic review summarized various predictors of poor recovery in different assessment domains, for example, psychosocial factors, history, pain, physical impairment, activity limitation, participation restriction, clinician factors, and therapeutic response.[9] However, due to methodological variability in these studies, such as cohorts, follow-up periods, outcome measures, and statistical techniques, there is a lack of consensus on the prognostic factors and implications on LBP outcomes.

The STarT Back Screening Tool (SBT) is a validated self-report questionnaire for stratifying LBP patients into subgroups to guide cost-effective interventions in primary care settings.[10] The SBT total score (in the range of 0–9) is determined by the number of potentially treatment modifiable physical and psychosocial indicators in the questionnaire, whereas the SBT psychosocial

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score (in the range of 0–5) is determined by the number of psychosocial indicators only. The SBT categorizes patients into low (total score 0–3), medium (total score >3; psychosocial score <4), or high (psychosocial score ≥4) risk of developing chronic LBP.[10] Although the SBT was developed as a screening tool to assist in patient stratification and care decisions, several recent studies have reported its predictive value in primary care and physical therapy settings.[11–13] Beneciuk et al[14] observed several SBT risk dependent relationships with unidimensional psychological measure scores in outpatient physical therapy settings. These results imply that it is possible to extend the application of the SBT outside the primary care settings where it was originally developed.

It is important to explore the predictive performance of the SBT in emergency care settings for acute LBP patients, who might benefit from appropriate management at an earlier stage. To our best knowledge, no research has been carried out to investigate the potential utility of the SBT in the context of emergency care settings. Therefore, this study aimed to examine whether the SBT could provide prognostic information for long-term outcomes of acute LBP patients presenting to the emergency department (ED) of a tertiary hospital in Singapore.

2. Methods

2.1. Study setting and participants

A prospective observational cohort study with consecutive recruitment was carried out in the ED of Singapore General Hospital (SGH) between February 2014 and July 2015. Patients aged 21 years and above, who presented to SGH ED with the primary complaint of acute LBP, were invited to participate in the study. Acute LBP patients were defined as those with an International Classification of Diseases 9th Revision (ICD-9) diagnosis code for LBP (ICD-9 codes: 722, 724, 7213, 7214, 7243, or 7245), and current symptom duration of no greater than 1 month before consulting emergency physicians. Patients were excluded if they had any of the following conditions: prior episodes of back pain within the preceding 2 years; LBP caused by acute traumatic back injuries, such as from accidents, falls, or playing sports, which injured ligaments, tendons, or muscle; and secondary medical conditions which require other concurrent interventions in the ED. Ethics approval for this study was granted by the SingHealth Centralised Institutional Review Board.

2.2. Procedure and baseline measures

Eligible patients were administered the SBT after the completion of ED consultation. SBT total and psychosocial scores were computed by summing up positive responses to respective items on the questionnaire. Patients were thereafter classified as low, medium, or high risk.[10] Demographics and baseline characteristics of patients were collected from either case notes or self-reports, including age, sex, race, weight, height, employment status, physical exercise frequency, LBP history (defined as having previous LBP episodes beyond 2 years), current LBP symptom duration, pain scores (rated using numeric pain rating scale [NPRS] in the range of 0–10) at ED triage and discharge, and comorbidities. Body mass index (BMI) and Charlson comorbidity index (CCI) score were calculated for each patient. Emergency physicians who managed LBP patients were blinded to SBT scores and risk categories of patients. All the prescriptions of treatment or follow-up referrals for LBP patients were at the discretion of ED physicians in line with current best practice and guidelines in Singapore.

2.3. Follow-up and outcome measures

Follow-up assessments were conducted via telephone interview at 6 weeks and 6 months after the initial ED consultation. Patients were asked to self-rate their average resting pain using NPRS. The attainment of at least a 2-point drop in NPRS[15] or being pain free was deemed as favorable outcome of pain. In addition, patient overall status was assessed by their responses to a question "Is your overall status better/the same/worse compared to 6 weeks/6 months ago?". An answer of "better" indicates favorable outcome of overall status.

2.4. Statistical analysis

Descriptive statistical analyses were performed to obtain demographics and baseline characteristics of patients. Results were described as means (standard deviations) for continuous variables and as frequency counts (percentages) for categorical variables. For the comparison between groups, Student *t* test or Wilcoxon rank-sum test for continuous variables, chi-square or Fisher exact test for categorical variables were used where appropriate. Missing data for BMI and baseline pain score were imputed using the means of respective observed values.

Univariable linear regression analyses were carried out on all putative predictors in relation to 6-month pain score. For exploratory purposes, variables with P values <.2 were retained for multivariable analysis. A multiple linear regression model for prediction of 6-month pain score was constructed through backward selection of candidate predictors (entry: $P<.05$; removal: $P>.1$). The adjusted R^2 was calculated to evaluate the model fit. Model checking was performed using suitable regression diagnostics and residual plots. The model was calibrated with bootstrapping of 200 bootstrap set of resamples. Statistical significance was set at $P<.05$. Data analyses were conducted using IBM SPSS Statistics 23 (IBM Corp, Armonk, NY) and R software, version 3.4.2.

3. Results

3.1. Participant characteristics

A total of 368 patients with back pain presenting to SGH ED were screened for eligibility. Of these patients, 168 (45.7%) were excluded from study participation. The major reason for ineligibility was reporting prior episodes of back pain within the preceding 2 years (n=86). Of the 200 patients recruited, 22 were lost to follow up and 1 dropped out with reason being refusal to participate further in the study (Fig. 1). Two BMI values (2 patients were uncertain about their weights and heights for BMI self-report) and 2 pain scores at ED (2 patients had no pain score records in ED case notes) were missing. There were no significant differences ($P>.05$) in demographics, SBT total and psychosocial scores, and baseline pain score between the 177 patients who completed the study and the 23 noncompleters (data not shown). Therefore, we excluded these 23 patients from further analyses. Of the 177 participants, 46 (26.0%) had experienced previous LBP onset beyond 2 years. The mean SBT total and psychosocial scores were 4.6 (SD=2.1) and 2.6 (SD=1.5), respectively. The demographics and baseline characteristics of participants were summarized in Table 1.

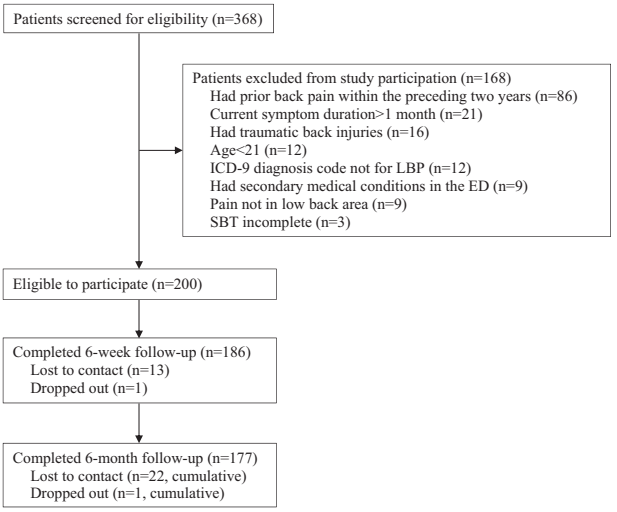

Figure 1. Study flow chart of patient recruitment and follow-up. ED = emergency department, ICD-9 = International Classification of Diseases 9th Revision, LBP = low back pain, SBT = STarT Back Screening Tool.

3.2. Predictors of 6-month pain score in multiple linear regression model

We performed the linear mixed-effect model given the repeated measures of pain score at baseline, 6 weeks, and 6 months. Results showed that pain score should be excluded from the mixed model. Hence, we used linear regression analysis to build the model as there are no other variables with repeated measures. In the univariable linear regression analyses, SBT total and psychosocial scores, age, sex, employment status, and LBP symptom duration showed association with 6-month pain score with P values $<.2$ (Table 2). Therefore, they were kept for further selection. Considering the clinical relevance of 6-week pain score to 6-month pain score, we also conducted univariable analysis for 6-week pain score. Results showed that 6-week pain score was associated with 6-month pain score with P values $<.2$. Thus, it was kept as a potential predictor variable. Although LBP history did not reach the significance threshold, it was still retained as a possible covariate due to its high clinical interest. In the multiple linear regression analysis, SBT psychosocial score lost predictive power, while SBT total score was identified as a significant predictor ($P<.05$) with coefficient of 0.125. Other variables which remained as independent predictors in the multiple linear regression model were age, employment status, LBP history, and 6-week pain score (Table 3). Among all variables in the final model, 6-week pain score was found to be the strongest predictor for 6-month pain score with coefficient of 0.500. The model achieved R^2 of 0.418 and adjusted R^2 of 0.401. Model calibration showed that the predicted 6-month pain score was close to actual 6-month pain score (Fig. 2).

3.3. Comparison of patient outcomes amongst SBT risk groups

The pain scores assessed at intake and each follow-up by SBT risk categorization are shown in Table 4. At baseline, the pain scores were 6.0, 6.1, and 6.9 for low, medium, and high risk groups respectively. In the first 6 weeks after ED consultation, pain scores dropped rapidly for all 3 risk groups with reduction ranging from 57.4% to 71.7%. The decrease of pain scores continued after 6 weeks but at a relatively slower pace. At 6 months, there were no statistically significant differences in pain score amongst risk groups ($P>.05$). The percentages of participants who had favorable outcomes by SBT risk categorization are also provided in Table 4. Overall, the percentages of participants who had at least 2-point drop in pain score, reported being pain free, and had improved status at 6 months were 82.5%, 59.9%, and 93.8%, respectively.

Table 1

Demographics and baseline characteristics of participants.

Variable	Participants (n = 177)
Age (mean, SD)	41.3 (14.2)
Male (n, %)	110 (62.1)
Race (n, %)	
Chinese	115 (65.0)
Malay	29 (16.4)
Indian	27 (15.3)
Others	6 (3.4)
Employment status (n, %) (employed full- or part-time outside the home)	153 (86.4)
BMI (mean, SD)	25.0 (4.9)
Physical exercise (n, %) (≥once per week before LBP onset)	87 (49.2)
CCI score (mean, SD)	0.55 (1.19)
LBP history (n, %) (had previous episodes of LBP beyond 2 y)	46 (26.0)
LBP symptom duration (n, %)	
0–7 d	141 (79.7)
8–14 d	19 (10.7)
15–30 d	17 (9.6)
SBT total score (mean, SD)	4.6 (2.1)
SBT psychosocial score (mean, SD)	2.6 (1.5)
SBT risk category (n, %)	
Low risk	53 (29.9)
Medium risk	69 (39.0)
High risk	55 (31.1)
Pain score at ED triage (mean, SD)	6.3 (2.5)
Pain score at ED discharge (mean, SD)	5.2 (2.8)

BMI = body mass index, CCI = Charlson comorbidity index, ED = emergency department, LBP = low back pain, SBT = STarT Back Screening Tool, SD = standard deviation.

Table 2

Association between patient characteristics and 6-month pain score in univariable linear regression analyses.

Variable	Six-mo pain score		
	B-coefficient* (95% CI)	R^2	*P*
SBT total score	0.201 (0.048 to 0.353)	0.037	.010
SBT psychosocial score	0.180 (−0.034 to 0.393)	0.016	.098
Age	−0.017 (−0.04 to 0.006)	0.012	.143
Sex	0.533 (−0.135 to 1.201)	0.014	.117
BMI	−0.022 (−0.089 to 0.044)	0.003	.508
Employment status	−0.849 (−1.793 to 0.095)	0.018	.078
Physical exercise	0.287 (−0.364 to 0.938)	0.004	.385
CCI score	0.091 (−0.185 to 0.366)	0.002	.516
LBP history	−0.436 (−1.177 to 0.305)	0.008	.247
LBP symptom duration	0.349 (−0.163 to 0.861)	0.010	.180
6-wk pain score	0.528 (0.427 to 0.629)	0.378	<.001

BMI = body mass index, CCI = Charlson comorbidity index, CI = confidence interval, ED = emergency department, LBP = low back pain, SBT = STarT Back Screening Tool.
* Unstandardized coefficient.

4. Discussion

Results from this study demonstrated that SBT total score was a significant predictor of long-term pain and it had better prognostic significance compared with SBT psychosocial score. There is growing evidence in the literature showing the important role of psychosocial factors in the progress toward chronic LBP.[16,17] However, the lack of prognostic value of psychosocial factors have also been reported in several studies.[18,19] This disparity might be explained by 2 reasons. First, psychosocial factors often include a multitude of variables that fall within different domains and they may emerge and act at different developmental stage of LBP. Second, LBP is a known complex, multifactorial, and biopsychosocial condition with contributions from various biomechanical, psychosocial, and individual factors. It is more likely that these factors interplay and take effect as a cluster resulting in LBP.[20] Our data suggest that the combination of physical and psychosocial factors in the SBT is a stronger determinant of long-term pain compared with psychosocial factors alone for the study setting.

In the univariable linear regression analyses, 6-week pain score accounted for 37.8% of the variance in 6-month pain score ($P < .001$). Results from multiple linear regression analysis also showed that 6-week pain score was a significant predictor of 6-month pain score. These data indicate that patients who have greater pain at 6 weeks are at a higher risk of developing persistent pain. Our results are corroborated by Wand et al[21] who reported that clinical profile collected at the subacute stage provided more valuable information than the clinical profile obtained from acute phase for the prediction of long-term pain and disability. Likewise, Enthoven et al[22] found that physical measures assessed at 4-week follow-up were more useful than initial measures for identifying patients who were at risk of poor outcome at 12 months. All these data suggest that patient assessment results obtained at a more delayed time point have a better predictive performance than assessment results from the acute phase.

In the multiple linear regression analysis, employment status had a marginal negative association with 6-month pain score. Our findings are generally consistent with previously published studies.[23,24] However, the underlying mechanism of such association remains unclear. Individuals who had prior episodes of back pain within the preceding 2 years were excluded from this study to ensure that the LBP onset was not a recurrence of a recent episode. LBP history also showed marginal negative association with 6-month pain score in this study, that is, patients who have had previous LBP episodes beyond 2 years reported less pain at 6 months than those who had not experienced LBP before. This

Table 3

Variables in the multiple linear regression model for prediction of 6-month pain score.

Variable	Six-mo pain score	
	B-coefficient* (95% CI)	*P*
SBT total score	0.125 (0.002 to 0.247)	.046†
Age	−0.018 (−0.036 to 0.001)	.069
Employment status	−0.755 (−1.546 to 0.036)	.061
LBP history	−0.535 (−1.115 to 0.045)	.070
6-wk pain score	0.500 (0.398 to 0.601)	<.001†
R^2	0.418	
Adjusted R^2	0.401	

CI = confidence interval, LBP = low back pain, SBT = STarT Back Screening Tool.
* Unstandardized coefficient.
† Significance level was $P < .05$.

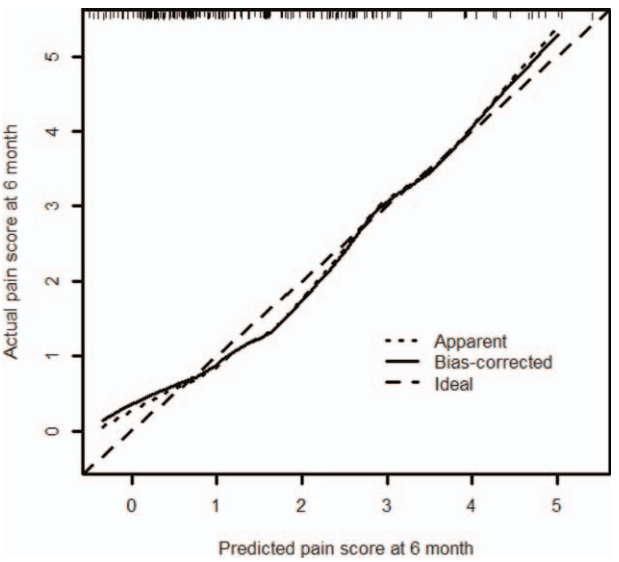

Figure 2. Predicated 6-month pain score and actual 6-month pain score in the model calibration.

Table 4

Participants who had favorable outcomes at 6 weeks and 6 months.

	SBT risk category*	Pain score†	Pain score drop ≥2 points	Pain free	Overall status improved
Baseline	Low risk	6.0 (2.6)			
	Medium risk	6.1 (2.7)			
	High risk	6.9 (2.2)			
6 wk	Low risk	1.7 (2.4)	41 (77.4%)	30 (56.6%)	51 (96.2%)
	Medium risk	2.6 (2.5)	47 (68.1%)	19 (27.5%)	64 (92.8%)
	High risk	2.4 (2.6)	44 (80.0%)	22 (40.0%)	50 (90.9%)
6 mo	Low risk	1.2 (1.9)	45 (84.9%)	33 (62.3%)	50 (94.3%)
	Medium risk	1.3 (2.0)	57 (82.6%)	43 (62.3%)	67 (97.1%)
	High risk	2.0 (2.6)	44 (80.0%)	30 (54.5%)	49 (89.1%)

SBT = STarT Back Screening Tool.

* Risk categories are based on baseline SBT stratifications.

† Presented as mean (standard deviation).

may be explained by learned management as patients with previous LBP episodes would have a better idea of their condition progression and how to cope with their symptoms.[25] This experience may consequently influence their perception of pain intensity.

In this study, the numbers of patients categorized into different risk groups were quite even by using the SBT. Substantial improvement of LBP was noticed in the first 6 weeks, which was followed by a slower rate of improvement subsequently until the end point at 6 months for all 3 risk groups. This trend was also reported in various studies and LBP management guidelines,[26–28] implying that significant change in LBP prognosis occurs in the initial few weeks after the onset of pain. The overall percentage of patients who reported being pain free in our study was 59.9% at 6 months, which was comparable with the results from Henschke et al[29] that 57.4% of the LBP patients who presented at primary care clinics were pain free at 6 months. Table 4 provides a very important finding that there was no observed SBT risk dependent relationship with 6-month pain score, indicating that risk stratification using the SBT may be premature for this setting. Analyses by risk categorization are only exploratory and further study with a larger sample size in each category in the ED setting would be required.

4.1. Limitations

There are limitations in our study. First, the prescriptions of treatment and follow-up referrals of LBP patients may not be standardized among emergency physicians. Hence, the impact of differences in management of LBP patients on outcomes cannot be ruled out. Second, patient outcomes of self-report pain and overall status may not capture patients' experience accurately. The utilization of validated outcome measures to reflect patients' progress will be required for future work. Third, as with many prognostic studies, our model is limited by a small sample and the predictive variables may have not been adequately identified.

5. Conclusions

A multiple linear regression model integrating SBT total score, patient demographics, and short-term pain score has shown predicative value in determining long-term pain for acute LBP patients presenting to the ED. The findings of this study suggest that the SBT has the potential to provide prognostic information for LBP patients in the emergency care settings. It also provides ED physicians with LBP related physical and psychosocial factors which may facilitate decision-making for LBP management.

Author contributions

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