INTRODUCTION
Low back pain is highly prevalent among the professional rescuers. Previous studies found that almost 96% of ambulance officers and over 80% of nurses experienced a back discomfort during or after the cardiopulmonary resuscitation (CPR) procedure. The cause of their back injury was related to the CPR delivery [1]. Chest compression in the procedure is an important step to maintain circulation. It is also a repetitive and laborious movement which is prone to cause low back injury. Despite the prevalence of pain, the relationship between trunk muscle activity during CPR and the risk of musculoskeletal injury was poorly understood. Surface EMG-based methods provide an easy access to the physiological processes that cause muscles to generate force and to produce movement. Therefore, the aim of this study is to investigate the patterns of trunk muscle activity for the manual chest compression during CPR.

METHODS
Eight experienced professional CPR rescuers (3 female, 5 male, age: 32±3.4yrs, height: 166±7.2cm, weight: 56±12kg) participated in this study.

A 10-channel MA-300 EMG system (Motion Labs., Baton Rouge, LA, USA) was used to record muscle activity with 1000 Hz sampling rate. Electrodes were placed bilaterally over the pectoris major (PMr, PMl), latissimus dorsi (LAr, LAl), rectus abdominis (RAR, RAl), erector spinae (ESr, ESL), and gluteus maximum (GMr, GMl).

Before testing, maximum voluntary contraction (MVC) of the recorded muscle was collected for normalization procedure of EMG. Then, the subjects performed CPR for 1 minute with a compression-ventilation ratio of 30/5 and frequency of 100 compressions per min. 10 sec data of EMG were recorded. At least 6 chest compression cycles were completed and averaged.

EMG data were full wave rectified and filtered (20-400HZ, 4 order Butterworth filter; 60 Hz notch filter). Then, data were normalized by MVC and chest compression time was normalized to a compression cycle. Root mean square (RMS) value of one chest compression cycle (RMS100%) and 20% cycle (RMS20%) were calculated.

RESULTS AND DISCUSSION
RMS of EMG of a chest compression cycle (RMS100%) for PMr, PMl, LAr, LAl, RAR, RAl, ESr, ESL, GMr, GMl are 11.7±4.36%, 13.8±4.24%, 5.96±1.14%, 4.65±1.54%, 6.01±5.42%, 8.13±6.52%, 7.25±4.79%, 9.10±5.86%, 10.47±7.23%, 12.35±8.01%, respectively. It shows that pectoris majors have the largest mean muscle activity, and latissimus dorsi have the least mean muscle activity during the chest compression.

CONCLUSIONS
Using EMG analysis, muscle recruitment patterns, amplitude, contraction timing, and co-contraction activity are easily observed. It can be applied to develop training strategy for CPR and to evaluate the risk of low back injury. Except comparison with low back pain subject, further study may include spectrum analysis as well as kinematic and kinetic information.

REFERENCES

ACKNOWLEDGEMENTS
The financial support of the National Science Council, ROC is highly acknowledged.