

Emergency Department Clinician Experiences and Perceptions Regarding Noncardiac Chest Pain: A Cross-Sectional Survey



Geoffrey Gelley, DC, MSc,^a Mohammad Zarrabian, DC, MD,^b and Steven Passmore, DC, PhD^{a,c}

ABSTRACT

Objectives: The objectives of this study are to report the responses of emergency department (ED) clinicians regarding the characteristics and management of patients with noncardiac chest pain (NCCP) and to explore clinician experiences with the current standard of care and whether nonpharmacologic or nonsurgical referral options would be considered.

Methods: A cross-sectional survey was delivered to 40 ED clinicians from hospitals in Winnipeg, Manitoba from 2012 to 2013. Data were reduced descriptively and thematically summarized to assess the characteristics of patients with NCCP along with the responses of ED clinicians regarding the management of NCCP.

Results: The survey response was 27 (67.5% response rate). They reported that patients with NCCP comprised a considerable amount of ED care and are a variable and heterogeneous population. Respondents agreed (63.0%) that onsite and on-call providers for NCCP referral would assist in patient management. Further, ED clinicians (66.7%) would consider referring patients with NCCP to a nonpharmacologic, nonsurgical clinical research study.

Conclusion: Clinicians in this study wanted better access to on-site referrals and outpatient clinics for patients experiencing NCCP after discharge and would consider nonpharmacologic or nonsurgical referral. (*J Manipulative Physiol Ther* 2019;42:159-166)

Key Indexing Terms: *Chest Pain; Emergency Service, Hospital; Surveys and Questionnaires; Perception; Chiropractic; Manipulation, Spinal*

INTRODUCTION

Patients with noncardiac chest pain (NCCP) use emergency department (ED) resources even though this condition may not actually reflect a true medical emergency.¹⁻³ Noncardiac chest pain is a condition

whereby the patient's chest pain is not attributable to any specific cardiac pathology.^{4,5} Both cardiology and emergency medicine have recently communicated the challenges they face when patients present with symptoms that suggest cardiac pathology,⁵⁻⁸ or a cardiac event in progress, but no cardiac etiology is found upon enzymatic analysis, electrocardiography, and exercise tolerance testing.^{2,8,9} Moreover, it is estimated that between 60% and 90% of those with NCCP who present to the ED have no cardiac etiology.¹⁰ Although the patient may experience peace of mind knowing they do not have a cardiac pathology, the pain they experience may persist and result in continued anxiety and fear^{11,12} and visits to their primary care physician.^{2,6,7,13-15} Furthermore, it has been reported that most patients with NCCP do not seek follow-up medical care.⁶ Delayed treatment and ensuing patient uncertainty may result from vague recommendations for further treatment.¹⁰ Both clinician and patient are placed in a context where they must reconsider patient management alternatives, including pharmacologic intervention and possible specialist referral. Arguably, the

^a Rady Faculty of Health Sciences, College of Rehabilitation Sciences, University of Manitoba, Winnipeg, Manitoba, Canada.

^b Section of Orthopedic Surgery, Department of Surgery, University of Manitoba, Winnipeg, Manitoba, Canada.

^c Faculty of Kinesiology & Recreation Management, College of Rehabilitation Sciences, University of Manitoba, Winnipeg, Manitoba, Canada.

Corresponding author: Geoffrey Gelley, DC, MSc, Gelley Chiropractic Clinic, 12-845 Dakota Street, Winnipeg, MB R2M 5M3 Canada. Tel.: +1 204 787 1899. (e-mail: drgelley@mymts.net).

Paper submitted January 29, 2017; in revised form November 17, 2017; accepted February 26, 2019.

0161-4754

Copyright © 2019 by National University of Health Sciences.
<https://doi.org/10.1016/j.jmpt.2019.02.004>

lingering question is referral to whom and for what medication or procedure because limited data are available regarding the treatment of NCCP.¹⁰

A differential diagnosis for those with chest pain includes pain of cardiac, pulmonary, gastrointestinal, psychogenic, or musculoskeletal origins.^{3,6,13-15} This is not to say that NCCP is entirely a benign condition because other life-threatening etiologies are possible.^{5,11,16} Patients assessed with NCCP may be erroneously diagnosed with nonanginal chest pain, atypical angina, or cardiac syndrome X (CSX).^{11,17-19} Patients with CSX demonstrate symptoms of angina pectoris with exertion but have normal coronary arteriograms.¹ Patients with CSX have been found to not respond favorably to typical anti-anginal medications, including calcium channel blockers, nitrates, α -1-adrenergic blockers, and the α -2 agonist clonidine.¹ Most of the studies on the treatment of CSX are not sufficient to provide insight on pathophysiology or an appropriate therapeutic intervention.¹

Clinicians who specialize in manual therapy¹⁵ have referred to NCCP as atypical chest pain, cervical angina, and pseudo-angina.^{11,14,17,19,20} There have been consistent findings among case reports and small experimental studies that symptoms may be mechanically reproducible with spinal palpation or thoracic compression.^{4,8,21-23} Palpation of the spine and manual loading of spinal segments have been consistently associated with intersegmental motion restriction^{4,8,15,22} and tenderness.^{4,8,11,15,19,21,22} A brief course of care including spinal and costotransverse joint manipulation of such restricted segments has been associated with decreased chest pain symptoms in isolated cases.^{4,7,11,14,16,21,22} A nonblinded trial reported on the benefit of chiropractic treatment vs self-management of patients with acute musculoskeletal chest pain that was observed at 4 and 12 weeks.¹² However, there were no significant differences between groups at 1-year follow-up.¹⁶ Burgstaller et al¹⁰ reported that spinal manipulation and home exercise were similarly effective for patients with musculoskeletal chest pain. Whether spinal manipulation has any therapeutic effect on a larger population of patients with NCCP remains uncertain and requires further investigation through robust prospective trials.

Before any prospective trial can be undertaken, the following must first be determined: (1) What is the clinical presentation of NCCP? (2) Which clinicians are observing NCCP? (3) How are they managing these patients? (4) Is this patient population large enough to support a clinical trial? (5) Would clinicians appreciate having alternative referral options upon encounters with these patients?

We hypothesize the following based on ED clinician recall: (1) An NCCP patient will likely be a postmenopausal female who has reoccurring pain episodes, and these findings would concur with what is described in the literature^{1,20}; (2) The presentation of patients with NCCP to the ED will be common, as recent reports^{1,3,13-15,17,21,24} indicate a prevalence as high as 30% among people with angina-like symptoms; and (3) Providers may be concerned regarding the uncertainty of clear

treatment and referral options presently available, and thus may consider an option for a referral for nonsurgical or non-pharmacologic study enrollment.

This purpose of this cross-sectional survey study was to determine the typical characteristics of patients with NCCP as recalled by ED clinicians and to collect the experiences and perceptions of ED clinicians in the management of NCCP and whether there was uncertainty with the current standard of care for these patients.

METHOD

This study was a single point of contact (cross-sectional) paper-based survey (Appendix) delivered to a convenience sample of 40 ED clinicians at 2 urban hospitals in Winnipeg, Manitoba from August 21, 2012, to March 13, 2013. Both EDs offer 24-hour, 7-day-a-week adult and pediatric emergency health care. This survey was developed by the University of Manitoba Chiropractic Working Group (UMCWG). The UMCWG are chiropractors (one of the chiropractors was also an orthopedic resident) who have an affiliation with the University of Manitoba and are productive contributors to research, education, or administration. The survey questions were determined by group discussion and through solicited feedback. A pilot survey was conducted with an orthopedic resident who was part of the UMCWG. The final draft of the survey was achieved through consensus by the UMCWG. The survey did not undergo a formal validation beyond the pilot with the target participant (M.Z.). To minimize bias, we used open- and closed-ended questions, and then when exploring our responses, we had 2 evaluators (S.P. and G.G.) identify themes. The survey included an option for ED clinicians to provide any written comments they had regarding NCCP.

Survey packages were individually delivered to on-duty ED clinicians at 2 Winnipeg hospitals and administered by one of the authors who was an orthopedic resident (M.Z.). The packages included a recruitment cover letter, the survey, and a stamped envelope with the office address of the primary investigator. Participants included clinicians from the ED who had the ability to communicate a clinical diagnosis within their scope of practice. The professions included attending physicians, residents, primary care physicians, and nurse practitioners. Emergency department clinicians were excluded if it was not within their clinical scope of practice to communicate a diagnosis.

Because the surveys were voluntary, completion and return of the questionnaire indicated consent to have participant data included in this research study. This consent method was explicitly stated to participants in the recruitment cover letter included with the survey, as was the recommendation to complete and submit the survey within 6 weeks. There were no formal participant reminders or follow-up once the surveys were distributed. All procedures, protocols, and the survey

Table 1. Survey Respondent Demographics ($n = 27$) and Screening, Diagnosis, and Treatment of Patients With NCCP Based on ED Clinician Survey Responses

Characteristics	
Age, M (SD)	38.6 (8.0)
Sex, n (%)	
Male	15 (55.6)
Female	12 (44.4)
ED position, n (%)	
Attending physician	16 (59.3)
Nurse practitioner	5 (18.5)
Resident	6 (22.2)
Years in practice, M (SD)	11.3 (9.4)
ED shifts/month, M (SD)	13.5 (4.1)
ED hours/shift, M (SD)	8.9 (1.2)
Patients with NCCP are a considerable amount of your ED practice, n (%)	25 (92.3)
# of patients with NCCP/month, M (SD)	19.0 (11.5)
Screening procedures ordered, n (%)	
Radiographs/imaging	21 (77.8)
ECG	27 (100.0)
Cardiac enzyme testing	26 (92.9)
Exercise tolerance testing	6 (22.2)
Other	3 (11.1)
Time spent (h) from intake to discharge with NCCP, M (SD)	6.1 (2.8)
ED action taken when NCCP persists and a cardiac event is ruled out (not mutually exclusive), n (%)	
Discharge without follow-up	3 (11.1)
Prescribe pharmaceuticals and discharge	15 (55.6)
Refer to primary care physician	24 (88.9)
Refer to cardiology	6 (22.2)
Refer to psychology/psychiatry	0 (0.0)
Other: internal medicine	1 (3.7)

ED, emergency department; M, mean; NCCP, noncardiac chest pain; SD, standard deviation.

instrument were approved by the University of Manitoba Health Research Ethics Board.

Survey data were described as raw numbers and percentages as they related to study objectives and survey questions for both response rate and percent of respondents

who shared common experiences and perceptions. Emergency department clinician self-reported responses were based upon their recall of cases in the ED. Descriptive statistics were applied, including analysis of central tendency (mean) and variability (standard deviation) of

Table 2. Survey Responses of ED Clinicians Regarding the Characteristics of Patients With NCCP

Age, M (SD)	40.5 (8.3)
Sex, n (%)	
Usually male	5 (18.9)
Usually female	2 (7.4)
Equally male or female	20 (74.1)
Menopausal status, n (%)	
Pre	10 (37.0)
Post	6 (22.2)
Unknown or either	11 (40.7)
Body morphology (not mutually exclusive), n (%)	
Underweight	1 (3.7)
Normal	9 (33.3)
Overweight	12 (44.4)
Obese	1 (3.7)
Unknown or varies	7 (25.9)
History with ED for NCCP	
Previously unknown	11 (40.7%)
Repeat visitors	16 (59.3%)
Patients with NCCP who become repeat ED visitors, n (%)	
<10%	4 (14.8)
10%-25%	8 (29.6)
26%-50%	4 (14.8)
>51%	0 (0.0)
Unreported	11 (40.7)
Concerned about referral or treatment options for NCCP, n (%)	
Strongly disagree	0 (0.0)
Disagree	11 (40.7)
Undecided	7 (25.9)
Agree	8 (29.6)
Strongly agree	1 (3.7)

Table 2. (continued)

On-site or on-call provider for NCCP referral would assist ED patient management, n (%)	
Strongly disagree	1 (3.7)
Disagree	3 (11.1)
Undecided	3 (11.1)
Agree	17 (63.0)
Strongly agree	3 (11.1)
Consider referral of diagnosed NCCP patients to nonpharmacologic, nonsurgical clinical research treatment intervention study, n (%)	
No	1 (3.7)
Unsure	8 (29.6)
Yes	18 (66.7)

ED, emergency department; M, mean; NCCP, noncardiac chest pain; SD, standard deviation.

both the study population and their responses. A thematic identification was applied to the responses entered in the comments section.²⁵ To systematically review the themes, the investigators independently reviewed any surveys with comments in an attempt to identify themes or subthemes. Any conflicts between investigators regarding identified themes or subthemes was discussed until a consensus was reached. As an a priori decision, 2 or more survey respondents (7.5%) must have identified a theme or subtheme for it to be reported. Once the themes or subthemes were identified, our intended next step was to perform a thematic analysis by developing a coding system to categorize themes followed by calculating frequencies for demographic characteristics.²⁵ Differences between comments from the 2 hospitals would entail 2-tail independent *t* tests and χ^2 tests with Bonferroni correction for multiple comparisons. However, we were unable to categorize themes, calculate the demographic frequencies, or calculate the differences between comments owing to the small number of respondent comments.

RESULTS

There were 40 surveys distributed and administered, of which 27 were returned (67.5% response rate). Responses were collected from ED clinicians with a broad range of experience and diverse backgrounds. The ED clinicians had a mean age of 38.6 (8.0) years and 11.3 (9.4) years of practice experience (Table 1). Of the 27 surveys completed, only 6 respondents (22.2%) provided written comments and therefore we were not able to perform a thematic analysis of the identified themes.

The data collected from the surveys, representative of clinician experiences and perceptions (Table 1), revealed that

92.3% of respondents agreed that patients with NCCP comprise a considerable amount of ED patient care. Most survey respondents reported they requested an electrocardiogram (ECG) (100% of respondents), cardiac enzymes (92.9% of respondents), and imaging (77.8% of respondents) tests. The respondents also reported patient time spent in the ED, from intake to discharge, which was 6.1 hours. A considerable number of patients reportedly were discharged with medications (55.6%) and instructed to follow up with their primary care practitioner (88.9%). Patients with NCCP who presented to the ED (Table 2) were reported on average to be 40 years of age with both sexes equally represented. Emergency department clinician recall of female patients' menopausal status (Fig 1) was either unknown (40.7%) or premenopausal (37.0%). Patient body morphology (Fig 2) was reported to range from normal (33.3%) to overweight (44.4%). Most patients with NCCP were recalled as being repeat visitors to the ED (59.3%). For ED clinician attitudes regarding NCCP (Table 2), 40.7% of clinicians disagreed that there was concern regarding the referral or treatment options for patients with NCCP, whereas 63.0% agreed that on-site and on-call providers for NCCP referral would assist in patient management. Moreover, 66.7% would consider referral of diagnosed patients with NCCP to a nonpharmacologic, nonsurgical clinical research treatment intervention study.

The following 3 basic themes were identified based on the comments from a small number of the ED clinicians: (1) Patients with NCCP are a highly variable and heterogeneous population (3 respondents). (2) ED clinicians would like better access to in-house referrals such as cardiology and exercise stress tests (2 respondents). (3) Emergency department clinicians require an outpatient clinic for referral of patients with NCCP who still have active chest pain after discharge from a hospital (1 respondent). Ostensibly, although a serious cardiac event may have

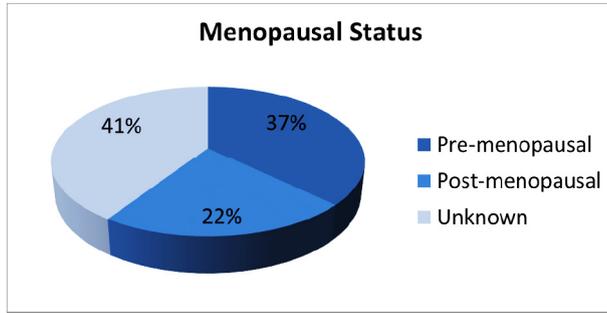


Fig 1. Noncardiac chest pain patient menopausal status as per emergency department clinician survey responses.

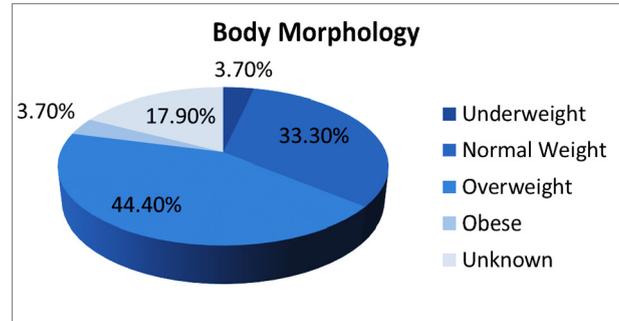


Fig 2. Noncardiac chest pain patient body morphology as per emergency department clinician survey responses.

been ruled out and the patients may be considered low risk, ED clinician responses indicate a need to explore and investigate further causes of the patient's chest pain.

DISCUSSION

Noncardiac chest pain is a common condition seen by the ED clinicians surveyed and taxes the resources of the hospital ED.^{3,13,14} Patients with NCCP comprise a considerable proportion of ED patient care with most (>78%) of these patients undergoing ECG and cardiac enzyme and imaging tests. The survey responses from clinicians is consistent with studies that note 50% to 80% of chest pain patients^{3,13-15} admitted to a hospital ED are discharged with a diagnosis of NCCP once they have undergone a clinical evaluation consisting of ECG, cardiac enzymatic analysis, and an exercise test.¹³ These patients often return for emergency care,^{1,13} and our survey respondents reported that almost 60% of patients with NCCP were repeat visitors to the ED. The prognosis for NCCP is excellent,^{6,10,11} yet Eslick and Talley⁶ report that 71% of patients with NCCP continue to experience chest pain. From the above, it is evident that the responses to our survey were consistent with the data published in a number of quantitative studies, which reinforces the external validity of this study.

The first of our themes derived from respondent comments asserts that patients with NCCP are a variable and heterogeneous population, which is also seen in CSX.¹ It has been suggested that patients with atypical or nonanginal chest pain might have a high probability of a pain disorder,^{3,11,17,19} with 1 study determining that 18% of chest pain patients had cervicothoracic angina²¹ and another study concluding that there is supportive evidence that CSX is a neurophysiologic rather than cardiogenic disorder.¹⁸ Beitman et al¹⁷ reported that cardiologists have noted that many of their patients with apparent cardiac symptoms have chest pain that is not cardiac in origin. Consequently, a distinction between true angina and cervical angina becomes necessary to differentiate cardiac

pathology from mechanical neck, costovertebral, and shoulder pain.^{11,14,15,19,22} Cervical angina is chest pain originating from the cervical and thoracic spines^{7,20,21} and in particular the C4 to T8 nerve roots.^{11,16,22} An observational study by Roche, Gardner, and Lewis³ of Australian hospital EDs reported that undifferentiated chest pain represents 3.5% of all patient presentations with most presentations being related to definite cardiac pathology (39%) followed by noncardiac chest pain (17%), musculoskeletal conditions (15%), and respiratory conditions (10%).

The mean age of patients with NCCP, as reported in our survey, was 38.6 years in contrast to the 48 years, 54 years, and 57 years reported in other studies.^{3,17,20,23} Noncardiac chest pain had previously been noted to preferentially affect peri- and postmenopausal women,^{1,20} which is contrary to the clinician responses from our survey that indicated that female patients were either premenopausal or their menopausal status was unknown. These differences may suggest a potentially different pathophysiology for menopausal females with chest pain.¹

Diagnostic testing, to rule out a cardiac episode and to confirm NCCP, most commonly includes ECG followed by cardiac enzyme testing and radiographs or imaging.^{2,11,13,20,21} Our survey results noted that the average duration of time for a patient to proceed from intake to diagnosis or discharge for NCCP was 6.1 hours, whereas another recent study reported patients left the ED within 4 hours.³ At discharge, our survey respondents typically provided patients with some type of pharmaceutical treatment or recommendation to follow up with their primary care physician. In contrast, Parsyan and Pilote¹ determined that after an extensive diagnostic workup to exclude cardiac and noncardiac causes of chest pain, physicians were unsure of the best plan of management for these patients. Moreover, the etiology of the patient's chest pain often remains elusive.^{9,12,15,19} In either case, it has been suggested that systematic manual palpation of the thoracic spine by an experienced clinician^{8,11,14,15} could allow for improvements in referral patterns to angiography or appropriate specialists.^{19,21}

Of interest to our identified themes, 63.0% of our respondents had agreed that on-site or on-call providers for NCCP referral would assist in ED patient care. Furthermore, 66.7% would consider referral of diagnosed patients with NCCP to a nonpharmacologic, nonsurgical clinical research treatment intervention study. This is encouraging, as a study by Jacobs²⁰ examined a patient cohort (n = 121) who underwent nonsurgical conservative treatment for cervical angina involving the use of a hard collar, intermittent traction, isometric exercises, and a combination of antiinflammatory and muscle relaxant medications. Most of these patients (n = 76) obtained complete relief while 50 patients had mild residual symptoms. Indeed, chest wall or sternal tenderness, paraspinal tenderness, and restricted cervical range of motion was significantly more frequent among patients with cervicothoracic angina and chest pain related to other musculoskeletal disorders.^{8,11,20-22} The frequent presentation of NCCP, as indicated by our survey respondents, along with their willingness to refer NCCP for nonsurgical conservative care, suggests that a prospective trial to determine whether manual therapies such as spinal manipulative therapy have a beneficial effect on a larger population of patients with NCCP is warranted.^{12,14-16} Previous smaller trials of spinal manipulative therapy and NCCP^{4,22} have demonstrated decreased chest pain symptoms, but a larger randomized clinical trial would allow for more robust conclusions about efficacy and economic viability.

Limitations and Future Studies

The data represent the experiences and approaches used by a modest-sized sample in one region of Canada. In addition, the participant responses and comments were subject to recall bias, which may affect the internal validity of this study. However, the survey responses, despite being drawn from clinician recall, concur with other epidemiologic and quantitative studies. The survey respondents were from 2 urban hospitals in a single province, therefore the generalizability of the findings to the population in general or other provinces should be interpreted with care. The small sample of respondent comments did not allow for a thematic analysis, thereby limiting our ability to identify any attitudinal bias on behalf of those ED clinicians who provided written comments. These limitations provide future direction to the study authors as they serve as a catalyst to undertake a retrospective review of ED charts as pertains to the assessment, diagnosis, and management of patients with NCCP. The results of this study were based on the ED clinician survey responses and in no way are the authors making any generalizations about a NCCP population as a whole. A future clinical trial, with a NCCP population of musculoskeletal etiology referred from ED clinicians, is feasible and warranted to further understand potential nonpharmacologic, nonsurgical management options that could include spinal manipulation, other manual therapies, and exercise. Interprofessional

collaboration along with a retrospective chart review will be paramount to improving the future research on, and improving clinical management of, the NCCP population.

CONCLUSION

The survey responses from ED clinicians from hospitals in Winnipeg, Manitoba suggest that patients with NCCP were identified as variable and heterogeneous. Emergency department clinicians reportedly manage NCCP through ruling out a cardiac episode, prescribing medication, and making a referral to the patient's primary care physician. Emergency department clinicians were uncertain about NCCP care options and wanted better access to on-site referrals and outpatient clinics for patients experiencing NCCP after discharge and would consider a nonpharmacologic/nonsurgical referral.

APPENDIX A. SUPPLEMENTARY DATA

Supplementary data to this article (Survey: Emergency Department Clinician Perceptions and Actions Regarding Non-Cardiac Chest Pain) can be found online at <https://doi.org/10.1016/j.jmpt.2019.02.004>.

FUNDING SOURCES AND CONFLICTS OF INTEREST

Dr. Passmore received grant funding from Research Manitoba and the Workers' Compensation Board of Manitoba when the study was conducted. Dr. Passmore also received an Endowed Professorship Salary Award at the University of Manitoba in the College of Rehabilitation Sciences, during the time of data collection. Dr. Passmore also received research support funding from the Manitoba Chiropractors Association. No other conflicts of interest were reported for this study.

CONTRIBUTORSHIP INFORMATION

Concept development (provided idea for the research): S.P.
Design (planned the methods to generate the results): G.G., M.Z., S.P.
Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): G.G., S.P.
Data collection/processing (responsible for experiments, patient management, organization, or reporting data): G.G., M.Z., S.P.
Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): G.G., M.Z., S.P.
Literature search (performed the literature search): G.G., S.P.
Writing (responsible for writing a substantive part of the manuscript): G.G., S.P.

Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): G.G., M.Z., S.P.

Practical Applications

- Patients with NCCP are a variable and heterogeneous population.
- Clinicians want better access to on-site referrals and outpatient clinics for patients experiencing NCCP.
- A future clinical trial with a NCCP population referred from ED clinicians is feasible and warranted to further understand potential non-pharmacologic, nonsurgical management options that could include spinal manipulation.

ACKNOWLEDGEMENTS

The authors thank Dr. Brian MacNeil for his input on this manuscript.

REFERENCES

1. Parsyan A, Pilote L. Cardiac syndrome X: mystery continues. *Can J Cardiol.* 2012;28(2 suppl):S3-S6.
2. Chambers JB, Marks E, Knisley L, Hunter M. Non-cardiac chest pain: time to extend the rapid access chest pain clinic? *Int J Clin Pract.* 2013;67(4):303-306.
3. Roche T, Gardner G, Lewis P. Retrospective observational study of patients who present to Australian rural emergency departments with undifferentiated chest pain. *Aust J Rural Health.* 2014;22(5):229-234.
4. Cooper SR, Pfefer MT. Management of non-cardiac chest pain with chiropractic care: a case report and brief review. *Top Integr Health Care.* 2011;2(3):1-7.
5. Stochkendahl MJ, Mickley H, Vach W, et al. Clinical characteristics, myocardial perfusion deficits, and clinical outcomes of patients with non-specific chest pain hospitalized for suspected acute coronary syndrome: a 4-year prospective cohort study. *Int J Cardiol.* 2015;182:126-131.
6. Eslick GD, Talley NJ. Natural history and predictors of outcome for non-cardiac chest pain: a prospective 4-year cohort study. *Neurogastroenterol Motil.* 2008;20(9):989-997.
7. Donovan J, Cassidy JD, Cancelliere C, et al. Beyond the spine: a new clinical research priority. *J Can Chiropr Assoc.* 2015;59(1):6-12.
8. Stochkendahl MJ, Vach W, Hartvigsen J, Hoilund-Carlsen PF, Haghfelt T, Christensen HW. Reconstruction of the decision-making process in assessing musculoskeletal chest pain: an exploratory study using recursive partitioning. *J Manipulative Physiol Ther.* 2012;35(3):184-195.
9. Kelly AM. What is the incidence of major adverse cardiac events in emergency department chest pain patients with a normal ECG, thrombolysis in myocardial infarction score of zero and initial troponin \leq 99th centile: an observational study? *Emerg Med J.* 2013;30(1):15-18.
10. Burgstaller JM, Jenni BF, Steurer J, Held U, Wertli MM. Treatment efficacy for non-cardiovascular chest pain: a systematic review and meta-analysis. *PLoS One.* 2014;9(8):e104722.
11. Stochkendahl MJ, Christensen HW. Chest pain in focal musculoskeletal disorders. *Med Clin North Am.* 2010;94(2):259-273.
12. Stochkendahl MJ, Christensen HW, Vach W, Hoilund-Carlsen PF, Haghfelt T, Hartvigsen J. Chiropractic treatment vs self-management in patients with acute chest pain: a randomized controlled trial of patients without acute coronary syndrome. *J Manipulative Physiol Ther.* 2012;35(1):7-17.
13. Knockaert DC, Buntinx F, Stoens N, Bruyninckx R, Delooy H. Chest pain in the emergency department: the broad spectrum of causes. *Eur J Emerg Med.* 2002;9(1):25-30.
14. Stochkendahl MJ, Christensen HW, Vach W, Hoilund-Carlsen PF, Haghfelt T, Hartvigsen J. Diagnosis and treatment of musculoskeletal chest pain: design of a multi-purpose trial. *BMC Musculoskelet Disord.* 2008;9:40.
15. Brunse MH, Stochkendahl MJ, Vach W, et al. Examination of musculoskeletal chest pain – an inter-observer reliability study. *Man Ther.* 2010;15(2):167-172.
16. Stochkendahl MJ, Christensen HW, Vach W, Hoilund-Carlsen PF, Haghfelt T, Hartvigsen J. A randomized clinical trial of chiropractic treatment and self-management in patients with acute musculoskeletal chest pain: 1-year follow-up. *J Manipulative Physiol Ther.* 2012;35(4):254-262.
17. Beitman BD, Basha I, Flaker G, et al. Atypical or nonanginal chest pain. Panic disorder or coronary artery disease? *Arch Intern Med.* 1987;147(9):1548-1552.
18. Rosen SD. From heart to brain: the genesis and processing of cardiac pain. *Can J Cardiol.* 2012;28(2 suppl):S7-19.
19. Constant J. The diagnosis of nonanginal chest pain. *Keio J Med.* 1990;39(3):187-192.
20. Jacobs B. Cervical angina. *N Y State J Med.* 1990;90(1):8-11.
21. Christensen HW, Vach W, Gichangi A, Manniche C, Haghfelt T, Hoilund-Carlsen PF. Cervicothoracic angina identified by case history and palpation findings in patients with stable angina pectoris. *J Manipulative Physiol Ther.* 2005;28(5):303-311.
22. Passmore SR, Dunn AS. Positive patient outcome after spinal manipulation in a case of cervical angina. *Man Ther.* 2009;14(6):702-705.
23. How J, Volz G, Doe S, Heycock C, Hamilton J, Kelly C. The causes of musculoskeletal chest pain in patients admitted to hospital with suspected myocardial infarction. *Eur J Intern Med.* 2005;16(6):432-436.
24. Stochkendahl MJ, Sorensen J, Vach W, Christensen HW, Hoilund-Carlsen PF, Hartvigsen J. Cost-effectiveness of chiropractic care versus self-management in patients with musculoskeletal chest pain. *Open Heart.* 2016;3(1):e000334.
25. Busse JW, Jim J, Jacobs C, et al. Attitudes towards chiropractic: an analysis of written comments from a survey of north american orthopaedic surgeons. *Chiropr Man Therap.* 2011;19(1):25.