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# Assessing Education and Exercise as Solutions for Aircrew Neck-trouble

*A Literature Review*

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Reference Document  
DRDC-RDDC-2018-D016  
March 2018

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This work is a deliverable under 03aa Air Human Effectiveness Project and the Neck and Back Trouble Mitigation Solutions Work Breakdown Element.

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## **Abstract**

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Griffon Helicopter aircrew neck trouble, at a minimum, is distracting and may deteriorate flying task performance and ultimately lead to permanent grounding. To this end, Defence Research and Development Canada (DRDC) and the Canadian Forces Environmental Medicine Establishment (CFEME) have been actively engaged in proposing and assessing solutions to the neck pain problem. One such proposed solution includes adoption of a “Professional Athlete” mentality involving both education and exercise. A review of the literature is used to assess the efficacy of education in mitigating neck pain. This analysis found that education alone has shown little to no effect in preventing neck pain or injury. Exercise or manual therapy showed slightly superior results, while the use of a combination of both education and exercise/manual therapy as the most effective way to manage the neck pain problem is clearly evident. Given this to be the case, curricula have been identified that, in combination with a practicum and/or training, promise to be effective in reducing aircrew neck trouble.

## **Significance to defence and security**

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Defence Research and Development Canada (DRDC) and the Canadian Forces Environmental Medicine Establishment (CFEME) have proposed, assessed, and provided scientific advice on 12 possible mitigating solutions, including a “Professional Athlete” mentality that involves education and exercise. In the near-term, 1 Wing plans to implement 6 of the 12 solutions, including core exercise and education. In the long-terms, this research has implications for 2 Canadian Air Division (CAD) and their responsibility for all aircrew training.

## Résumé

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Les troubles cervicaux chez les membres d'équipage des hélicoptères Griffon sont, à tout le moins, une source de distraction et nuisent à l'exécution de leurs tâches en vol, mais ils peuvent, au bout du compte, les contraindre à une interdiction de vol. À cet égard, Recherche et développement pour la défense Canada (RDDC) et le Centre de médecine environnementale des Forces canadiennes (CMEFC) se sont activement engagés à proposer et à évaluer des solutions au problème de douleur cervicale. L'une de ces solutions proposées comprend l'adoption d'une mentalité « d'athlète professionnel » conjuguant l'éducation et l'exercice. Une revue de la littérature a été réalisée pour évaluer l'efficacité de l'éducation dans l'atténuation des douleurs cervicales. Cette analyse a révélé que l'éducation, utilisée seule, a peu d'effet, voire aucun effet sur la prévention de la douleur ou des blessures cervicales. L'exercice ou la massothérapie ont affiché des résultats légèrement supérieurs, alors que la combinaison de l'éducation et de l'exercice et/ou de la massothérapie s'est clairement avérée la solution la plus efficace pour prendre en charge les douleurs cervicales. Si tel est le cas, les programmes d'études combinés à un stage ou à une instruction promettent d'être efficaces pour réduire l'incidence des troubles cervicaux chez les membres d'équipage.

## Importance pour la défense et la sécurité

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Recherche et développement pour la défense Canada (RDDC) et le Centre de médecine environnementale des Forces canadiennes (CMEFC) ont proposé, évalué et fourni des conseils scientifiques sur douze solutions d'atténuation possibles, y compris une solution mettant de l'avant une mentalité « d'athlète professionnel » combinant des volets d'éducation et d'exercices. À court terme, la 1<sup>re</sup> Escadre prévoit mettre en œuvre six des douze solutions, incluant des séances d'éducation et d'exercices de stabilisation du tronc. À long terme, cette recherche aura des répercussions sur la 2<sup>e</sup> Division aérienne du Canada (2 DAC) et sa responsabilité à l'égard de l'instruction de tous les membres d'équipage.

# Table of contents

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Abstract . . . . .	i
Significance to defence and security . . . . .	i
Résumé . . . . .	ii
Importance pour la défense et la sécurité . . . . .	ii
Table of contents . . . . .	iii
Acknowledgements . . . . .	iv
1 Introduction . . . . .	1
2 Review of the literature . . . . .	2
2.1 Education for neck pain . . . . .	2
2.2 Exercise/manual therapy for neck pain . . . . .	2
2.3 Education in combination with exercise/manual therapy for neck pain . . . . .	3
2.4 Education curricula with practical components . . . . .	4
3 Conclusion . . . . .	6
References . . . . .	7
Annex A Notional Course Curriculum for CH-146 Helicopter Aircrew . . . . .	10
Annex B Notional Course Curriculum for General Aircrew . . . . .	12
Annex C Notional Course Curriculum for Flight Surgeons . . . . .	14
List of symbols/abbreviations/acronyms/initialisms . . . . .	15

## **Acknowledgements**

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The authors would like to acknowledge Major Erin Smith for her initial guidance on this paper.

# 1 Introduction

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Neck- and back-trouble have negatively affected helicopter aircrew since the 1960s (Delahaye et al., 1970). While the Royal Canadian Air Force (RCAF) has been actively investigating rotary-wing aircrew back pain issues since the 1980s, efforts to investigate issues related specifically to neck pain have begun only recently. In a 2004 RCAF survey, 82% of CH-146 Griffon helicopter aircrew reported neck pain (Adam, 2004). This finding was further supported in a more recent 2014 survey, where 75% of Griffon helicopter aircrew reported the same (Chafé & Farrell, 2016). Given the high prevalence of injury in Griffon aircrew, there is vested interest on behalf of the RCAF to find solutions that mitigate aircrew neck pain. DRDC, Directorate of Technical Airworthiness and Engineering Support (DTAES), and the Canadian Forces Health Services (CFHS) have been engaged in finding a solution to this problem since the early 2000s. Since 2012, the focus has been on mitigating (near-term) solutions, and the Neck- and Back-trouble Mitigating Solutions Work Breakdown Element (WBE: 03aa01) was initiated under the Air Human Effectiveness Project (03aa).

One of the initial activities for this new WBE was to propose aircrew neck pain mitigating solutions under contract (Ferne & Mayich, 2013; Fischer et al., 2013), and the proposed solutions were analysed and prioritised (Chafe, 2013). The list of proposed solutions (in order of priority) is as follows:

1. Revised Workload Distribution and Smart Scheduling
2. Helmet Fit
3. “Professional Athlete” Mentality: Education and Exercise
4. Neck-Supported Mass Study: Identify Helmet System Requirements that Mitigate Neck Pain
5. Helmet System Support Devices
6. Radar Altimeter Repeater Monitor
7. “See Through Floor” Capability
8. Seat Ergonomics

The next phase of the WBE was to assess each of the prioritised solutions for their ability to mitigate neck pain. To date, all the proposed solutions have been assessed, except for the education component of the “Professional Athlete” mentality solution. The professional athlete mentality consists of two pain mitigating strategies: education and exercise. This solution recognises that education or exercise alone might not mitigate neck pain, but that a combinatorial approach may be effective. This assessment, based on a review of the literature, aims to provide evidence for the components of the “Professional Athlete” mentality solution in mitigating neck pain. Proposed curricula aimed at reducing aircrew neck trouble are provided in the annexes.

## 2 Review of the literature

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Within the context of the “Professional Athlete” mentality as a neck pain-mitigating solution, there are two requirements for success: 1) the sharing of information and 2) acting on that information. In other words, the sharing of information is considered “education,” while acting on that information may include a practicum, and “exercise” may be one of several activities that aircrew undertake. The following brief review provides evidence to the effectiveness or lack thereof of education and exercise (and in combination) in mitigating neck pain. Curricula aimed at reducing aircrew neck trouble are also proposed.

### 2.1 Education for neck pain

Neck pain is a major public health problem, both in terms of the effects on quality of life and the cost of Government health care (Daffner et al., 2003). Other potential indirect costs include loss of work and future effects on employability (Borghouts, Koes, Vondeling, & Bouter, 1999; Daffner et al., 2003). According to The Bone and Joint Decade 2000 to 2010 Task Force on Neck Pain and Its Associated Disorders, referred to as the Neck Pain Task Force (NPTF), education is recommended as a useful intervention for Whiplash-Associated Disorders (WAD) (Guzman et al., 2008). In fact, patient education has become routine practice for both the management of post-injury WAD as well as Neck pain and Associated Disorders (NAD) (Gross et al., 2012; Yu et al., 2016).

Since the NPTF was published in 2008, several systematic reviews have investigated the clinical effectiveness of patient education on WAD and NAD (Gross et al., 2012; Meeus, Nijs, Hamers, Ickmans, & Van Oosterwijck, 2012; Verhagen, Scholten-Peeters, S., de Bie, & Bierma-Zeinstra, 2007). In a clinical study evaluating the best approach to managing whiplash injuries, Emergency Departments (ED) designed an educational intervention trial consisting of active management advice and the distribution of an information pamphlet (Lamb et al., 2012). The control group was provided care advice typically received in an ED. Follow-up data were collected at 2 weeks, 4 months, 8 months, and 12 months post-ED visit. No statistically- or clinically-significant differences were observed in patients who received the educational intervention. In another study involving workers’ compensation recipients with first-time neck pain, the efficacy of an educational booklet on functional outcomes of neck pain was assessed (Derebery, Giang, Gatchel, Erickson, & Fogarty, 2009). At 2 weeks, 3 months, and 6 months following baseline assessments, functional measurements and pain questionnaires were completed. It was concluded that education did not improve patient outcomes. A similar neck pain patient study was conducted to assess the efficacy of education strategies on mitigating pain in acute WAD patients (Teasell et al., 2010). Again, no evidence for the benefit of education alone was noted, at both intermediate and long-term follow-up periods. Overall, representative evidence from the literature suggests that patient education alone does not mitigate neck pain and is less effective than other treatment options.

### 2.2 Exercise/manual therapy for neck pain

Recently, common treatments such as physiotherapy and massage therapy have been shown to mitigate neck pain (Salmon, Harrison, & Neary, 2011). In a trial assessing the effects of standard ED care compared to neck pain management advice (education), no differences were noted in scores on the Neck Disability Index (NDI) (Lamb et al., 2013). Physiotherapy, however, showed modest benefits compared to neck pain management advice at the 4 month follow-up period (short-term). No differences were noted at 8 (intermediate) or 12 month (long-term) follow-up periods. Physiotherapy that includes exercise and



manual therapy has also shown effectiveness in accelerating recovery and function (Hurwitz et al., 2008), as well as reducing pain (short-term) (Rushton et al., 2011) and work absenteeism (Provinciali, Baroni, Illuminati, & Ceravolo, 1996). In another study, patients with chronic neck pain were assigned to receive either massage therapy or a self-care educational booklet as an intervention (Sherman, Cherkin, Hawkes, Miglioretti, & Deyo, 2009). Follow-up telephone interviews at 4, 10, and 26 weeks post-intervention were used to assess outcomes using the NDI. Overall, massage therapy was shown to be more effective than education at the 4 week (short-term) follow-up period.

In the Swedish Air Force, supervised regular muscle strength training is believed to prevent neck pain in helicopter pilots, possibly by improving neck-flexor function post-intervention (Ång & Harms-Ringdahl, 2006). Further evidence also exists for exercise therapy as a treatment regime for neck pain in helicopter aircrew (Salmon et al., 2011). However, more specific strategies for mitigating neck pain still need to be evaluated. In line with this, the Royal Danish Air Force (RDAF) is currently developing a specifically-tailored exercise intervention to reduce the incidence and prevalence rates of neck pain in helicopter pilots and aircrew (Murray, Lange, Nørnberg, Sjøgaard, & Sjøgaard, 2015). The protocol would consist of 3 training sessions (20 minutes each) per week during working hours and the primary outcome would be change in neck pain. In a similar manner, the Royal Air Force has institutionalised an Aircrew Conditioning Programme (ACP) for fighter aircraft pilots, and plans are being made to roll out a similar programme for rotary-wing aircrew.

Evidence from the literature indicates that exercise/manual therapy has potential for mitigating the pain and burden associated with neck pain, at least in the short-term. Ongoing studies will help support this evidence.

### **2.3 Education in combination with exercise/manual therapy for neck pain**

The review of the literature showed that education is largely ineffective at preventing neck pain, while exercise or manual therapy has the potential to mitigate neck trouble. The current rationale is that educational strategies that complement clinical practice (i.e., putting education into practice), are the most effective way to manage neck pain (Côté et al., 2016). Structured patient education in combination with range of motion exercises (physiotherapy), strengthening exercises, and massage therapy have all been investigated.

For instance, the long-term benefits of a combinatorial educational and physical program on neck pain have previously been demonstrated in a cohort of public servants (Mongini et al., 2012). Education consisted of an explanation of the program and its main purposes, with particular emphasis on pain and its origins in the cranio-facial-cervical area. The physical component of the program consisted of a relaxation and brief neck and shoulder exercises to be performed several times a day. At one-year follow up, 40% of the participants reported a reduction in neck pain, while 50% reported a reduction in analgesic drug intake. In a similar study, a physical and educational intervention consisting of relaxation and posture exercises as well as the use of visual feedback was carried out in a working community (Rota et al., 2011). The presence of symptoms was investigated by way of an interview checklist. Headaches, as well as neck and shoulder pain were also assessed by way of clinical examinations. At 6 months, the probability of the presence of any type of neck trouble symptom was lower in the study group compared to the control group. Multimodal physiotherapy, including exercise, mobilization, and expert advice

following initial education has also shown to be more effective than education alone by a physiotherapist in reducing workdays lost due to injuries of the neck (Lamb et al., 2013; Lamb et al., 2012).

A combinatorial approach to mitigating neck pain that includes both education and manual therapy appears to hold promise. In order to adopt this approach in the RCAF, curricula are required. The following section outlines potential approaches to the implementation of such curricula.

## **2.4 Education curricula with practical components**

Our literature review shows that education in combination with a practicum, training, or some practical experience is beneficial for reducing neck pain. To that end, and based on the assessment activities and results conducted under this project, education curricula (table of contents only) were developed for the RCAF's consideration.

The first consideration in developing a curriculum was to determine the student populations who would benefit from this training. We identified 3 groups of students who may benefit from an aircrew neck-trouble mitigation course: CH-146 Griffon Helicopter aircrew, general aircrew, and flight surgeons. Each group will have slightly different objectives. For instance, CH-146 aircrew would likely want to understand how they can reduce neck pain specifically for their platform and missions. General aircrew (i.e., new recruits) would need to understand how normal operations over the length of a career could contribute to chronic neck pain if not properly monitored. Flight surgeons would be interested in their role in preventing and treating neck pain. And so the education plan may be tailored for each group even though the course curriculum template remains the same.

The Curriculum template consists of a course aim, and the following modules:

1. Neck pain problem (background)
2. Neck pain mechanisms (causes and biomechanics)
3. Neck pain mitigating solutions/Flight Surgeon role in prevention and treatment
4. Next Steps (future research, procurement, training, etc.)
5. Summary

Again, the modules may be added to, edited, or deleted to fit the education plan objectives. A possible layout for module 3 for CH-146 Aircrew involves a description of solutions that mitigate the 5 primary causal factors: human factors, body-borne equipment, aircrew behaviours, aircraft workspace, and organisational factors as shown in Annex A (Farrell et al., 2017). Note that in Annex A, education modules have a practicum component listed here as follows:

- Exercise (self-paced general fitness program)
- Helmet Fit (in field working with ALSE technicians)
- Counter Weights (in field working with ALSE technicians)
- Neutral Postures (formal training and informal info-sharing)
- Smart Scheduling (self-paced scheduling wherever possible)
- Task Sharing (formal training)

Annexes B and C include possible curricula for General aircrew and Flight Surgeons, respectively. Note that in Annex B, some of the sub-modules are crossed out to show that tailoring would need to be made for general aircrew that may include the fighter pilots where, for example, task sharing is not applicable as a solution. For Flight Surgeons, the entire solutions module (module 3) is suggested to be replaced with the role flight surgeons play in preventing and treating chronic neck pain.<sup>1</sup>

Finally, Annexes A, B, and C are notional examples of how education plans flow from the proposal and assessment of solutions. Although DRDC and CFEME stand ready to contribute to the content of these (or other) curricula, other RCAF stakeholders will need to take ownership of the education and training components of neck pain mitigation.

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<sup>1</sup> A 50-minute lecture was given at the 2017 Flight Surgeon Course (Farrell, 2017), which was a condensed version of proposed curriculum found in Annex C.

### 3 Conclusion

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A review of the existing literature on the benefits of education alone, or in combination with exercise, in mitigating neck pain has shown mixed results. The majority of clinical studies have shown little to no statistically significant differences in patients who were given information on post-injury management (education) versus those that were not. Information sharing did not reveal any significant improvements in patient outcomes. Thus, there was little benefit to giving additional information to patients post-injury as a mitigating strategy to neck pain in both the short- and long-term. Similarly, preventative education showed little to no efficacy in preventing neck pain or injury. Exercise alone has shown limited success in mitigating neck pain in patients. Manual therapy (such as physiotherapy or massage therapy) has shown modest effects in the short-term for patients with neck pain. Physiotherapy has successfully demonstrated acceleration in patient recovery and improvements in neck functionality. Massage therapy has also been shown to be an effective means of lowering neck pain in patients in the short-term. A combinatorial approach to the neck pain problem, employing both educational and manual therapy approaches, has shown potential. To that end, potential curricula are being proposed for the consideration of the RCAF.

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# **Annex A Notional Course Curriculum for CH-146 Helicopter Aircrew**

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## **Course Title**

CH-146 Griffon Helicopter Aircrew Neck-trouble Mitigating Solutions

## **Aim**

To equip CH-146 Griffon Helicopter Aircrew with the understanding of aircrew neck pain that may develop during normal operations over a career, and how the risk of chronic neck pain may be reduced by a variety of mitigating solutions.

## **Module 1 – The problem**

- 1.1 Historic Review
- 1.2 Survey Results (2004 & 2014)
- 1.3 Possible solutions (foreshadow of solutions)

## **Module 2 – Mechanisms**

- 2.1 Five Causal Factors
- 2.2 Neck ‘Trouble’ Definitions (maybe pain metric, and pain vs performance results)
- 2.3 Neck Pain Biomechanics

## **Module 3 – Solutions**

- 3.1 Who Aircrew Are
  - 3.1.1 Education (current course)
  - 3.1.2 Exercise (self-paced General Fitness program)
- 3.2 What Aircrew Wear
  - 3.2.1 Helmet Fit (in field)
  - 3.2.2 Counter Weights (in field)
- 3.3 What Aircrew Do
  - 3.3.1 Neutral Postures (formal training, informal info-sharing)
  - 3.3.2 Smart Scheduling (self-paced scheduling)
  - 3.3.3 Task Sharing (formal training)
- 3.4 Where Aircrew Work (info only)
  - 3.4.1 G, Vibration, and Ergonomics
  - 3.4.2 Multi-Function Displays for Pilots and Flight Engineers
  - 3.4.3 Seat Ergonomics
- 3.5 Who Aircrew Belong to (info only)
  - 3.5.1 Mission Type
  - 3.5.2 Mission Length

## **Module 4 – Next Steps**

- 4.1 Integrating Solutions (What Aircrew can do, What RCAF can do)
- 4.2 Longitudinal study to determine solution effectiveness



- 4.3 Helmet Systems procurement requirements
- 4.4 Future Solutions

**Module 5 – Summary**

- 5.1 The Problem
- 5.2 Mechanisms
- 5.3 Solutions
- 5.4 Next Steps

## **Annex B Notional Course Curriculum for General Aircrew**

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### **Course Title**

*Aircrew Neck-trouble Mitigating Solutions*

### **Aim**

To equip *aircrew* with the understanding of aircrew neck pain that may develop during normal operations over a career, and how the risk of chronic neck pain may be reduced by a variety of mitigating solutions.

### **Module 1 – The problem**

- 1.4 Historic Review
- 1.5 Rotary Wing and *Fast Jet* Survey Results (2004, 2014, & 2016)
- 1.6 Possible solutions (foreshadow of solutions)

### **Module 2 – Mechanisms**

- 2.4 Five Causal Factors
- 2.5 Neck ‘Trouble’ Definitions (maybe pain metric, and pain vs performance results)
- 2.6 Neck Pain Biomechanics

### **Module 3 – Solutions**

- 3.6 Who Aircrew Are
  - 3.6.1 Education (current course)
  - 3.6.2 Exercise (self-paced General Fitness program)
- 3.7 What Aircrew Wear
  - 3.7.1 Helmet Fit (in field)
  - 3.7.2 Counter Weights (in field)
- 3.8 What Aircrew Do
  - 3.8.1 Neutral Postures (formal training, informal info-sharing)
  - 3.8.2 Smart Scheduling (self-paced scheduling)
  - ~~3.8.3 Task Sharing (formal training)~~
- 3.9 Where Aircrew Work (info only)
  - 3.9.1 G, Vibration, and Ergonomics
  - ~~3.9.2 Multi-Function Displays for Pilots and Engineers~~
  - ~~3.9.3 Seat Ergonomics~~
- 3.10 Who Aircrew Belong to (info only)
  - 3.10.1 Mission Type
  - 3.10.2 Mission Length

### **Module 4 – Next Steps**

- 4.5 Integrating Solutions (What Aircrew can do, What RCAF can do)
- 4.6 Longitudinal study to determine solution effectiveness
- 4.7 Helmet Systems procurement requirements
- 4.8 Future Solutions

**Module 5 – Summary**

5.5 The Problem

5.6 Mechanisms

5.7 Solutions

5.8 Next Steps

## **Annex C Notional Course Curriculum for Flight Surgeons**

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### **Education Course Title**

*Aircrew* Neck-trouble Mitigating Solutions

### **Aim**

To equip *aircrew* with the understanding of aircrew neck pain that may develop during normal operations over a career, and how the risk of chronic neck pain may be reduced by a variety of mitigating solutions.

### **Module 1 – The problem**

- 1.7 Historic Review
- 1.8 Rotary Wing and *Fast Jet* Survey Results (2004, 2014, & 2016)
- 1.9 Possible solutions (foreshadow of solutions)

### **Module 2 – Mechanisms**

- 2.7 Five Causal Factors
- 2.8 Neck ‘Trouble’ Definitions (maybe pain metric, and pain vs performance results)
- 2.9 Neck Pain Biomechanics

### **Module 3 – Flight Surgeon Role**

- 3.11 Prevention
  - 3.11.1 Education
  - 3.11.2 Exercise
  - 3.11.3 Neutral Postures
  - 3.11.4 Smart Scheduling
  - 3.11.5 Helmet Fit
  - 3.11.6 Counter Weights (pros and cons)
  - 3.11.7 “Go No-Go decision-making”
- 3.12 Treatment

### **Module 4 – Next Steps**

- 4.9 Epidemiology studies
- 4.10 Understanding neck pathology
- 4.11 Application of Pain Metric as a decision tool for Go No-Go decision metric

### **Module 5 – Summary**

- 5.9 The Problem
- 5.10 Mechanisms
- 5.11 Solutions
- 5.12 Next Steps

## List of symbols/abbreviations/acronyms/initialisms

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ACP	Aircrew Conditioning Programme
CAD	Canadian Air Division
CAF	Canadian Armed Forces
CFEME	Canadian Forces Environmental Medicine Establishment
CFHS	Canadian Forces Health Services
DRDC	Defence Research and Development Canada
DTAES	Directorate of Technical Airworthiness and Engineering Support
ED	Emergency Department
NAD	Neck Pain and Associated Disorders
NDI	Neck Disability Index
NPTF	Neck Pain Task Force
NSM	Neck-Supported Mass
RCAF	Royal Canadian Air Force
RDAF	Royal Danish Air Force
WAD	Whiplash-Associated Disorders
WBE	Work Breakdown Element

**DOCUMENT CONTROL DATA**

\*Security markings for the title, authors, abstract and keywords must be entered when the document is sensitive

1. ORIGINATOR (Name and address of the organization preparing the document. A DRDC Centre sponsoring a contractor's report, or tasking agency, is entered in Section 8.)  DRDC – Toronto Research Centre Defence Research and Development Canada 1133 Sheppard Avenue West P.O. Box 2000 Toronto, Ontario M3M 3B9 Canada			2a. SECURITY MARKING (Overall security marking of the document including special supplemental markings if applicable.)  CAN UNCLASSIFIED	
			2b. CONTROLLED GOODS  NON-CONTROLLED GOODS DMC A	
3. TITLE (The document title and sub-title as indicated on the title page.)  Assessing Education and Exercise as Solutions for Aircrew Neck-trouble: A Literature Review				
4. AUTHORS (last name, followed by initials – ranks, titles, etc., not to be used)  Benjamin, L.; Carnduff, L.; Farrell, P. S. E.				
5. DATE OF PUBLICATION (Month and year of publication of document.)  March 2018		6a. NO. OF PAGES (Total pages, including Annexes, excluding DCD, covering and verso pages.)  19		6b. NO. OF REFS (Total references cited.)  29
7. DOCUMENT CATEGORY (e.g., Scientific Report, Contract Report, Scientific Letter.)  Reference Document				
8. SPONSORING CENTRE (The name and address of the department project office or laboratory sponsoring the research and development.)  DRDC – Toronto Research Centre Defence Research and Development Canada 1133 Sheppard Avenue West P.O. Box 2000 Toronto, Ontario M3M 3B9 Canada				
9a. PROJECT OR GRANT NO. (If appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant.)  03aa		9b. CONTRACT NO. (If appropriate, the applicable number under which the document was written.)		
10a. DRDC PUBLICATION NUMBER (The official document number by which the document is identified by the originating activity. This number must be unique to this document.)  DRDC-RDDC-2018-D016		10b. OTHER DOCUMENT NO(s). (Any other numbers which may be assigned this document either by the originator or by the sponsor.)		
11a. FUTURE DISTRIBUTION WITHIN CANADA (Approval for further dissemination of the document. Security classification must also be considered.)  Public release				
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Griffon Helicopter aircrew neck trouble, at a minimum, is distracting and may deteriorate flying task performance and ultimately lead to permanent grounding. To this end, Defence Research and Development Canada (DRDC) and the Canadian Forces Environmental Medicine Establishment (CFEME) have been actively engaged in proposing and assessing solutions to the neck pain problem. One such proposed solution includes adoption of a 'Professional Athlete' mentality involving both education and exercise. A review of the literature is used to assess the efficacy of education in mitigating neck pain. This analysis found that education alone has shown little to no effect in preventing neck pain or injury. Exercise or manual therapy showed slightly superior results, while the use of a combination of both education and exercise/manual therapy as the most effective way to manage the neck pain problem is clearly evident. Given this to be the case, curricula have been identified that, in combination with a practicum and/or training, promise to be effective in reducing aircrew neck trouble.

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Les troubles cervicaux chez les membres d'équipage des hélicoptères Griffon sont, à tout le moins, une source de distraction et nuisent à l'exécution de leurs tâches en vol, mais ils peuvent, au bout du compte, les contraindre à une interdiction de vol. À cet égard, Recherche et développement pour la défense Canada (RDDC) et le Centre de médecine environnementale des Forces canadiennes (CMEFC) se sont activement engagés à proposer et à évaluer des solutions au problème de douleur cervicale. L'une de ces solutions proposées comprend l'adoption d'une mentalité « d'athlète professionnel » conjuguant l'éducation et l'exercice. Une revue de la littérature a été réalisée pour évaluer l'efficacité de l'éducation dans l'atténuation des douleurs cervicales. Cette analyse a révélé que l'éducation, utilisée seule, a peu d'effet, voire aucun effet sur la prévention de la douleur ou des blessures cervicales. L'exercice ou la massothérapie ont affiché des résultats légèrement supérieurs, alors que la combinaison de l'éducation et de l'exercice et/ou de la massothérapie s'est clairement avérée la solution la plus efficace pour prendre en charge les douleurs cervicales. Si tel est le cas, les programmes d'études combinés à un stage ou à une instruction promettent d'être efficaces pour réduire l'incidence des troubles cervicaux chez les membres d'équipage.

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Muscle Activation; Neck Load; neck pain; tbody-borne equipment; helmet systems; Night Vision Goggles; Head Up Displays; Counter Weights