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How often is neck and vestibulo-ocular physiotherapy treatment recommended in people with persistent post-concussion symptoms? A retrospective analysis



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ABSTRACT

Background: Persistent post-concussion symptoms (PPCS) are complex, and typically involve multidisciplinary assessment and management. The neck and vestibulo-ocular systems are recognised as potential contributors to PPCS, yet it is not clear how often treatment for these systems is warranted.

Objectives: To explore how often neck and vestibulo-ocular treatment is received or recommended in people with PPCS.

Design: Retrospective chart review.

Method: De-identified clinical service data for the calendar year of 2017 were extracted from a single concussion service provider in Dunedin, New Zealand. A summary of the individual assessments and treatments received were extracted and used to determine how often cases were considered to require physician or neuropsychological assessment; and how often cases received or were recommended neck and/or vestibulo-ocular physiotherapy treatment.

Results/findings: 147 cases were included in this study. Physician assessment was considered required in 25 cases (17%), and neuropsychological assessment in 90 cases (61%). For physiotherapy, neck treatment was received or recommended in 80 cases (54%), and vestibulo-ocular treatment in 106 cases (72%). Notably, this included 59 cases (40%) where both neck and vestibulo-ocular treatment were received or recommended.

Conclusions: The high proportion of cases receiving or recommended neck and vestibulo-ocular treatment strongly suggests both these systems often contribute to PPCS, often in overlap. While based on retrospective data, these findings highlight the value of routine neck and vestibulo-ocular examination in the assessment and management of PPCS. Further prospective study would be beneficial to explore these proportions in more detail and in other regions.

1. Introduction

Concussion is a significant and prevalent health concern and has considerable overlap with the term mild traumatic brain injury (Marshall et al., 2015b). Detailed population based research in New Zealand has shown that at least 749 people per 100,000 sustain a mild traumatic brain injury every year (Feigin et al., 2013). While it is proposed most people recover within 10–14 days (Makdissi et al., 2013; McCrory et al., 2017), as many as 47.9% of people report persisting symptoms a year after a concussion (Theadom et al., 2016). These data highlight the challenge of persistent post-concussion symptoms (PPCS), clinically defined as a constellation of non-specific symptoms that can arise from multiple structures and do not necessarily reflect ongoing injury to the brain (McCrory et al., 2017).

There is a growing awareness of the potential impact of neck and vestibular/oculomotor dysfunction in concussion. A wide range of emerging evidence now supports the rationale for neck and vestibulo-ocular dysfunction (Elkin et al., 2016; Ellis et al., 2015; Leddy et al.,

2015; Makdissi et al., 2013; Marshall et al., 2015a; Schneider, 2016), and aspects of assessment and treatment (Alsalaheen et al., 2010; Mucha et al., 2014; Reneker et al., 2018; Schneider, 2016; Schneider et al., 2014). Reflecting this growing awareness, the 2017 consensus statement on concussion in sport (McCrory et al., 2017) highlights that when symptoms persist: “There is preliminary evidence supporting the use of: ... a targeted physical therapy programme in patients with cervical spine or vestibular dysfunction ...” (p. 842). The potential for PPCS to arise from neck and vestibular/oculomotor dysfunction reinforce the need to be able to accurately identify sources of symptoms contributing to PPCS, which can then lead to individualised treatment. Many authors acknowledge the complexity of PPCS and advocate for a multi-disciplinary approach to assessment and treatment (Cheever et al., 2016; Grabowski et al., 2017; Makdissi et al., 2013; Matuszak et al., 2016; McCrory et al., 2017; Pabian et al., 2017). In line with this, Ellis et al. (2015) suggest categorising PPCS based on dysfunction within specific subsystems: physiologic (brain), vestibular-ocular and cervicogenic systems, and treating accordingly. While the authors

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acknowledge the potential for considerable overlap between categories, the value of recognising pathophysiological dysfunction in specific systems and using this to guide management is well supported. Notably, targeted neck and vestibulo-ocular treatment with physiotherapy has been shown to be effective in the management of sports-related concussion (Schneider et al., 2014).

While a better understanding of neck and vestibulo-ocular dysfunction in PPCS is emerging, it is not clear how often these systems contribute to PPCS. This is problematic for concussion services as it is not clear whether routine assessment of these systems is justified, or if review should occur on a case-by-case basis. Currently, research into the role of the neck and vestibulo-ocular systems in PPCS is relatively preliminary (Alsalaheen et al., 2010; Grabowski et al., 2017; Kennedy et al., 2017; Park et al., 2018; Reneker et al., 2018; Treleaven, 2017). However, these studies all indicate that careful assessment of these systems is important to identify sources of PPCS, and can facilitate targeted treatment. A better understanding of how common these issues are in people with PPCS would help providers of concussion services design and deliver good care.

In New Zealand, we have a unique opportunity to explore data from a nationally funded concussion service for people with PPCS. This service is widely available to people with PPCS and provides a multidisciplinary team approach to assessment, which allows individualised recommendations for management. A local concussion service provider (APM Workcare Ltd) routinely includes physiotherapy assessment of the neck and vestibulo-ocular systems for all referrals. This creates the opportunity to explore how often the neck and vestibulo-ocular systems contribute to PPCS by performing a retrospective analysis of data from this local concussion service. The purpose of this study is to investigate how often neck and vestibulo-ocular treatment was received or recommended in people with PPCS accessing a concussion service where the neck and vestibulo-ocular systems are routinely assessed.

2. Methods

This study describes a retrospective analysis of data extracted from a concussion service provider for the 2017 calendar year. Ethical approval was granted by the University of Otago Human Ethics Committee (HD18/019).

2.1. The concussion service

Data was gathered from APM Workcare Ltd. (APM), a provider of a New Zealand nationally funded concussion service designed for people with PPCS. Data was sought from APM specifically for the Dunedin region as consultation with staff identified that clients are routinely referred for both a neck assessment and a vestibulo-ocular assessment with experienced physiotherapists. Note that while this concussion service is available nationwide, in other regions and with other providers the performance of neck and/or vestibulo-ocular assessment is variable. For the purposes of this study it was important for all cases to receive both neck and vestibulo-ocular assessment such that the outcomes of these assessments could be reliably reported.

Clients with a diagnosis of concussion (or suspected concussion) are referred to the concussion service by medical doctors if they have persistent symptoms and/or are likely to require further assessment and support. An overview of the concussion service is presented in Fig. 1. Essential aspects of this service are an initial triage assessment from the key worker (in this team, an occupational therapist), multidisciplinary case review based on this assessment and any other available information, followed by physiotherapy neck and vestibulo-ocular assessment. Note that it is usual for the key worker to take the lead on concussion education and manage a graduated return to activities with all clients. Further assessment such as by the physician, neuropsychologist or other specialists are performed on a case by case basis. Note that by ‘case review’, we refer to review and discussion of

the case between health professionals based on clinical notes and assessment findings available; by ‘assessment’, we refer to a specific face-to-face appointment between the client and the health professional including physical assessment as appropriate. The concussion service allows for some limited provision of treatment while assessments are being completed or to resolve straightforward cases. Clients exit the concussion service either after making a recovery, or with treatment recommendations tailored to their individual needs (e.g. neck and/or vestibulo-ocular rehabilitation). It is common for cases requiring further rehabilitation to receive this outside of the concussion service. As all cases underwent case review by a rehabilitation physician and neuropsychologist, this also allowed reporting of how often these professions considered an assessment by them was warranted. As part of the contractual arrangements of this service all treatment recommendations are required to relate to the concussion for which clients are referred, and not pre-existing issues. ‘Neck’ treatment in this study refers to treatment for cervical spine musculoskeletal dysfunction related to the concussion injury; while ‘vestibulo-ocular’ treatment refers to treatment for vestibular (central and peripheral), oculomotor or functional balance dysfunction related to the concussion injury.

2.2. Data extraction and analysis

Data were extracted in a two-step process designed to maintain client confidentiality and provide only de-identified data to the research team for analysis. First, clinical service data were extracted, and cases were classified based on treatment received. Second, in cases where treatment was not received the treatment recommendations from case notes were reviewed and provided to the research team. In this way, the research team was able to classify cases as having neck and/or vestibulo-ocular treatment received or recommended.

De-identified clinical service data were extracted from the APM electronic record system into an excel spreadsheet by staff blind to the study purpose and shared with the research team. Demographic data included date of injury, date of first assessment, age, sex and ethnicity. The data showed dates and codes for each assessment or treatment received by clients within the concussion service and the responsible clinician. The clinical outcomes of treatment were not available to the researchers. Filters were used to limit the data to cases seen by clinicians within the Dunedin region in the 2017 calendar year. As the key workers would often travel to surrounding regions to assess clients, cases were defined as in the Dunedin region when both the key worker and subsequent multidisciplinary assessment were performed by staff based in Dunedin. This ensured cases were limited to the Dunedin region where we could be certain all cases received both neck and vestibulo-ocular assessment. Cases were excluded if their injuries did not fit within the clinical diagnosis of concussion e.g. moderate-severe traumatic brain injury, as determined by the concussion service physician. Such cases could be identified by early exit from the concussion service.

The coding of the data allowed sessions for assessment or treatment to be distinguished, while familiarity with the clinicians involved enabled the research team to classify assessment and treatment by profession. This allowed the number of physician and neuropsychology assessments to be tracked. Similarly, treatment sessions by physiotherapists could be identified as neck or vestibulo-ocular physiotherapy as different clinicians were responsible for these different aspects of care. This allowed cases to be classified as having received neck and/or vestibulo-ocular treatment within the concussion service. Cases who had received treatment could be classified based on these data. Cases who had not received treatment within the concussion service were referred to APM staff to review a discharge report for the treatment recommendations from neck and vestibulo-ocular assessment. An administrator recorded the treatment recommendations in a spreadsheet supplied by the researchers and allowed the remaining cases to be classified. Cases where neither neck nor vestibulo-ocular

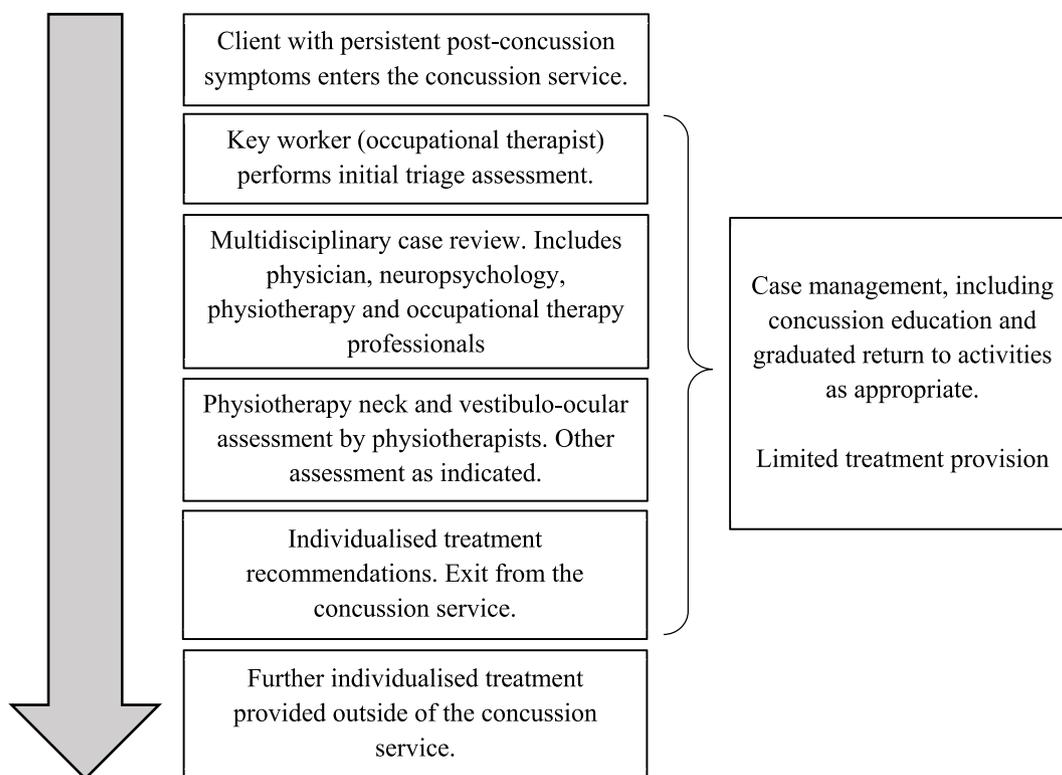


Fig. 1. Overview of the concussion service.

treatment were recommended were classified as ‘no physiotherapy recommended’. Cases with insufficient information to classify clearly were noted and also considered ‘no physiotherapy recommended’.

3. Results

In the Dunedin region 149 cases were seen during the 2017 calendar year. Two cases were excluded from the study as on physician case review they were considered to have a moderate-severe brain injury and were exited from the concussion service. Thus, 147 cases were included in the study for analysis. Demographic information for all cases is provided in Table 1. Unfortunately, data on ethnicity were often missing and therefore unable to be reported. The mean age of the group was 33.1 years (SD 17.55) and the mean time since concussion at the point of first assessment was 46.2 days (SD 51.81).

An overview of outcomes from the multidisciplinary case review and physiotherapy assessment is shown in Fig. 2. The physiotherapy treatments received or recommended are presented in Fig. 3. Of the 147 cases, 21 (14%) received or were recommended only neck treatment while 47 (32%) received or were recommended only vestibulo-ocular treatment. In 59 cases (40%), both neck and vestibulo-ocular treatment

were received or recommended. In summary, 80 (54%) cases received or were recommended neck treatment while 106 (72%) cases received or were recommended vestibulo-ocular treatment. For the remaining 20 (15%) cases, no physiotherapy was recommended. Of these cases, 12 received treatment solely from other members of the multidisciplinary team and eight had insufficient information for classification. Overall 127 cases (86%) received or were recommended either neck and/or vestibulo-ocular physiotherapy.

The cases considered to require physician or neuropsychological assessment are summarised in Table 2, including an examination of the subsequent physiotherapy treatment recommendations for these cases. Physician assessment was considered required in 25 cases (17% of all cases), while neuropsychological assessment was considered required in 90 cases (61% of all cases). Both physician and neuropsychological assessment were considered required in 18 cases (12% of all cases), while neither physician nor neuropsychological assessment were considered required in 51 cases (35% of all cases).

4. Discussion

This study highlights that in a multidisciplinary concussion service designed for people with persistent post-concussion symptoms, neck and vestibulo-ocular treatment is very often recommended. In this study treatment for the neck was recommended in over half of cases (54%), while treatment for the vestibulo-ocular system was recommended in nearly three-quarters of cases (72%). Interestingly, neck and vestibulo-ocular treatment were often both recommended (40%), suggesting concurrent issues. Previous research has highlighted the key role of the neck and vestibulo-ocular systems post-concussion (Ellis et al., 2015; Grabowski et al., 2017; Reneker et al., 2018), and current guidelines call for the assessment and treatment of these systems in people with persistent symptoms (McCroly et al., 2017). Furthermore, there is good quality evidence for the effectiveness of cervico-vestibular rehabilitation post-concussion (Schneider et al., 2014). To this background, the current study adds some insight into how often treatment of

Table 1
Case demographics.

	n = 147
Sex	
Female	84 (57%)
Male	62 (42%)
Data not available	1
Age	
Mean (SD)	33.1 years (17.55)
Range	9–86 years
Median	26 years
Days since concussion at first assessment	
Mean (SD)	46.2 days (51.81)
Median	30

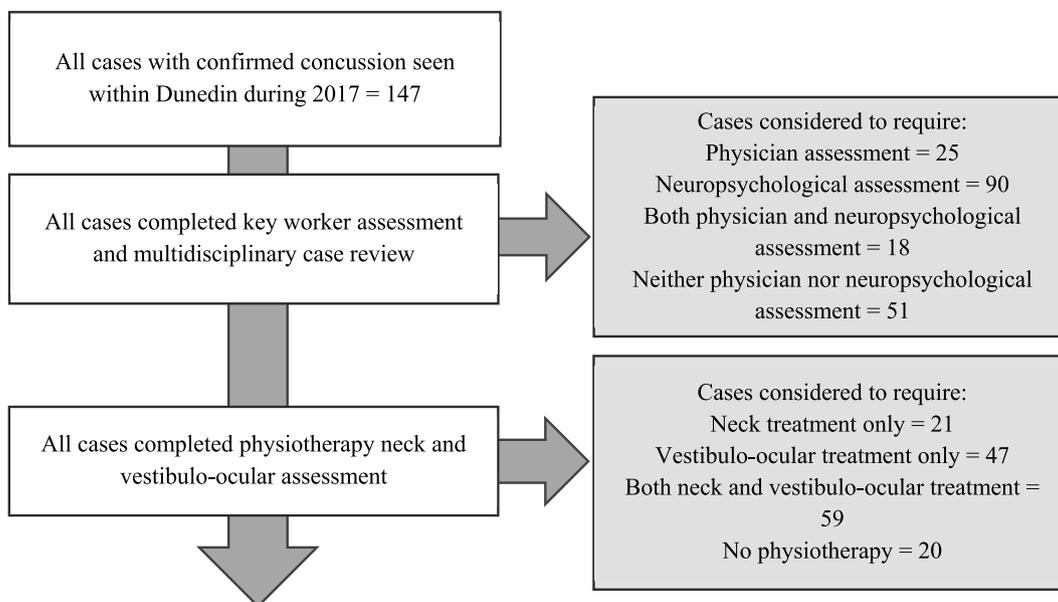


Fig. 2. Overview of outcomes from multidisciplinary case review and physiotherapy assessment.

the neck and vestibulo-ocular systems is recommended as part of the management of PPCS.

Previous research considering how often treatment from various professions is recommended in concussion services is quite limited. Vargo et al. (2016) examined interdisciplinary referrals in an academic medical centre that is also a county hospital and a level 1 trauma centre, based in the United States of America. Patients were all diagnosed with concussion (excluding those with brain bleeds), but were not limited to those with PPCS (days since injury at initial visit mean 51 days, SD 161, median 16). A median of 16 days since injury suggests a large number of acute concussion cases (< 10 days post-concussion). The service was provided by two physicians and reports the referrals made. Physiotherapy was the discipline most commonly referred to

(28%), and the most common reasons for referral were balance/vestibular therapy (19%) and neck pain (12%). Compounding these differences, 42% of physiotherapy referrals were unaccounted for (sessions were either received at an outside facility, or the patient did not schedule or did not show). While the areas of referral align with our findings, how often vestibular and neck therapy was recommended is quite low in comparison to the current study. Further notable differences are that in this current study, following case review just 17% of cases required physician assessment. This is, perhaps, an indicator in this current study of confidence in the multidisciplinary team and the strong rehabilitation emphasis in the New Zealand context. These differences likely arise from substantially different models of care, with specific differences from this study including: study setting, study

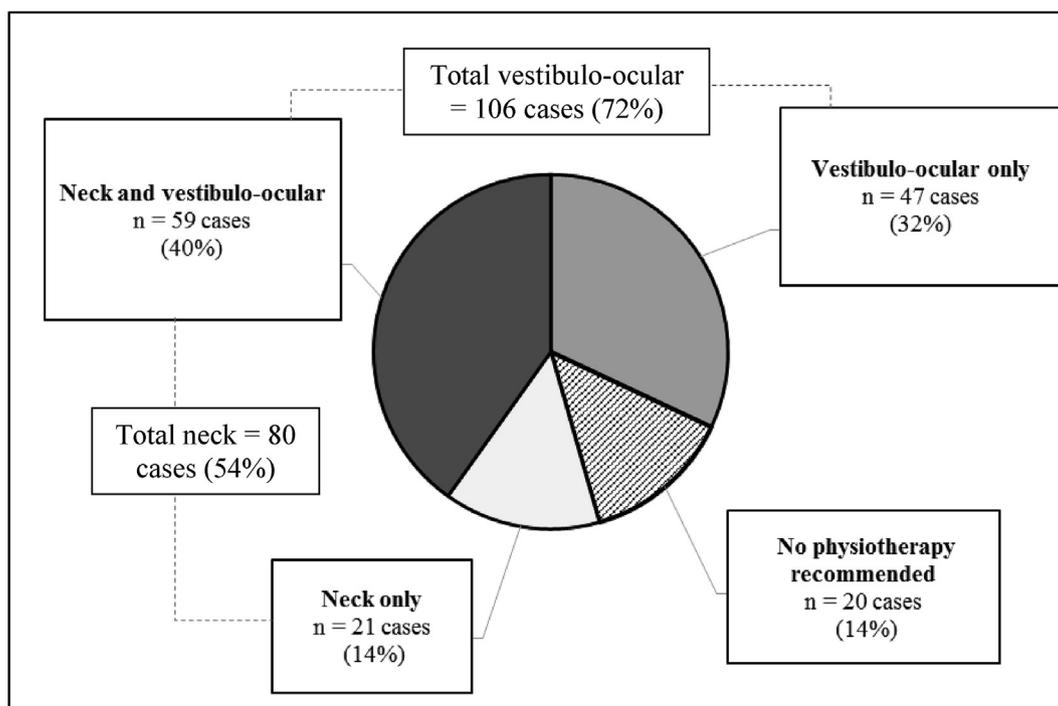


Fig. 3. Proportion of cases with physiotherapy neck and/or vestibulo-ocular treatment received or recommended (n = 147).

Table 2

Summary of cases considered to require physician or neuropsychological assessment following multidisciplinary case review, including subsequent physiotherapy treatment recommendations.

n = 147		
Physician assessment considered required		
Vestibulo-ocular physiotherapy only	5 (20%)	25 (17%)
Neck physiotherapy only	3 (12%)	
Vestibulo-ocular and neck physiotherapy	16 (64%)	
No physiotherapy	1 (4%)	
Neuropsychological assessment considered required		
Vestibulo-ocular physiotherapy only	27 (30%)	90 (61%)
Neck physiotherapy only	11 (12%)	
Vestibulo-ocular and neck physiotherapy	42 (47%)	
No physiotherapy	10 (11%)	
Both physician and neuropsychological assessment considered required		
Vestibulo-ocular physiotherapy only	3 (17%)	18 (12%)
Neck physiotherapy only	3 (17%)	
Vestibulo-ocular and neck physiotherapy	12 (67%)	
No physiotherapy	1 (6%)	
Neither physician nor neuropsychological assessment considered required		
Vestibulo-ocular physiotherapy only	18 (35%)	51 (35%)
Neck physiotherapy only	10 (20%)	
Vestibulo-ocular and neck physiotherapy	13 (25%)	
No physiotherapy	10 (20%)	

population (not all cases with PPCS), physician-only assessment, and it is not clear to what extent judgement was based on a physical examination of the neck and vestibulo-ocular system. It is interesting to note that both studies describe multidisciplinary care, but the model or flow of care through these disciplines have differences that appear important. The collaborative model described here may result in increased use of rehabilitation services. However, despite a range of differences both Vargo et al. (2016) and the current study highlight the neck and vestibular systems as commonly involved and important to address following concussion injuries.

Many authors suggest a multidisciplinary approach to assessing clients with PPCS, and providing targeted treatment informed by this assessment (Grabowski et al., 2017; Makdissi et al., 2013; Matuszak et al., 2016; McCrory et al., 2017; Pabian et al., 2017; Reneker and Cook, 2015; Schneider, 2016). As part of this approach, many authors advocate for a thorough physical examination of the neck and vestibulo-ocular system to better understand individual PPCS and tailor treatment accordingly (Ellis et al., 2015; Kennedy et al., 2017; Reneker et al., 2018; Schneider et al., 2014). This is supported by preliminary evidence that assessment of the neck and vestibulo-ocular system post-concussion can identify cervicogenic and vestibulo-ocular sources of symptoms (Kennedy et al., 2017; Reneker et al., 2018; Treleaven et al., 1994), and evidence that cervico-vestibular physiotherapy treatment is effective (Schneider et al., 2014). The physical examination component is important, as it has been acknowledged that symptoms alone do not distinguish symptom source (Leddy et al., 2015) and it precludes clinicians from making appropriate decisions about neck or vestibulo-ocular dysfunction based on case review. It is interesting to note that those requiring physician assessment appear more likely to have both neck and vestibulo-ocular treatment recommended (64–67% of these cases, in comparison to 40% of all cases). This likely reflects increased complexity of those cases assessed by the rehabilitation physician. As seen in this study, physiotherapists may have expertise in either neck or vestibulo-ocular assessment, but not both. If this is the case, it seems important for clients to have the opportunity to access care in both these areas to guide their management appropriately, although this may be challenging in smaller regions where specialist staff may not be available. In these situations there may be a case for physiotherapists working in concussion to learn basic assessment and treatment of both the neck and vestibulo-ocular systems. Overall, a range of evidence indicates that multidisciplinary teams providing concussion services

should include physiotherapists able to offer neck and vestibulo-ocular assessment. That treatment for the neck was recommended in over half of cases (54%), while treatment for the vestibulo-ocular system was recommended in nearly three-quarters of cases (72%), presents a strong case that this assessment should be routine.

While this study shows clinicians often identified both neck and vestibulo-ocular problems requiring treatment, it also highlights the extent to which these problems coexist. This issue is reflected in recommendations for individualised assessment and treatment in the consensus statement for concussion in sport (McCrory et al., 2017), and indicates a complex layering of potential symptom sources that require individualised assessment and management. Ellis et al. (2015) suggest that post-concussion disorders can be identified, including: physiological (brain metabolism related), vestibulo-ocular and cervicogenic, based on pathophysiological mechanisms underlying symptoms. While the concussion service examined in this study uses different processes, the philosophy of identifying problems in subsystems and tailoring treatment accordingly is very much in alignment. However, when multiple symptom sources contribute in overlap as seen in this study and other recent work (Reneker et al., 2018), it may be useful to conceptualise disorders in these subsystems as layers rather than categories – in recognition of the extent of overlap that can occur.

4.1. Limitations

As a retrospective analysis, this study has limitations worth acknowledging. The purpose of this study required data from a concussion service that routinely assessed the neck and vestibulo-ocular systems, in order to establish how often treatment were received or recommended. In order to meet these conditions this study focussed on a particular service provider and region. Therefore, our results are reflective of the care provided by a particular multidisciplinary team in a particular region, and may have limited generalisability to other populations or other concussion services. It was also unfortunate that ethnicity data was largely missing, which would have helped characterise the study population further. This is a limitation of the retrospective design and could be addressed by future prospective study. On the positive side limiting the exclusion criteria to those without concussion (n = 2) resulted in good capture of cases during 2017 (147 of a possible 149 cases), age and sex data were available, and the cases included in this study represent persistent symptoms well with a mean time since concussion of 46.2 days. For reference, PPCS are typically defined as those persisting for longer than 10–14 days (Makdissi et al., 2013; McCrory et al., 2017). The large standard deviations for both mean age and mean time since concussion highlight the variability within the case group. This reflects the inclusive nature of the concussion service in New Zealand, and the heterogeneity of people with concussion. The two-step data analysis which reported physiotherapy treatment received or recommended may also have introduced errors. The first step which reported treatment received within the concussion service required only review of service data, while the second step required review of the clinical notes to extract the treatment recommendations. It is possible that the second step introduced some errors to the data. To minimise the effect of bias at this step the data extraction was performed by an administrator familiar with the concussion service and blind to the study purpose. It would also be interesting to report on a wider set of assessment and treatment recommendations. Reporting in this study has been limited to variables that were routinely performed for all clients – multidisciplinary team case review and physiotherapy neck and vestibulo-ocular assessment. This ensures the data reported is based on evaluation of all cases seen in this region and not just a selection, but does mean that numerous other professions and recommendations that form part of the post-concussion care are not represented (e.g. neurologist, speech language therapist, optometrist etc.). Finally, specific tests and measures utilized by the physiotherapists in the concussion service were not standardized across the therapists and could not be obtained

through this study. Thus, differences in testing may have resulted in differences in the recommendations for treatment. These limitations would be best addressed by future prospective research.

5. Conclusion

This study reports how often neck and vestibulo-ocular treatment were received or recommended in people with PPCS, via a retrospective audit of clinical notes from a concussion service provider in Dunedin, New Zealand. The findings highlight that the neck and vestibulo-ocular systems are not only potential contributors to PPCS as has been described in previous research, but very often warrant specific physiotherapy treatment as part of multidisciplinary care. In this study neck treatment was received or recommended in over half of cases, and vestibulo-ocular treatment in nearly three-quarters of cases. These data strongly support the value of routine neck and vestibulo-ocular assessment, and the role of physiotherapists as part of a multidisciplinary team in managing people with PPCS. Whether this involves a single physiotherapist with skills in both neck and vestibular rehabilitation or separate more specialised clinicians, identifying specific issues in both these systems is an essential step towards individualised, evidence-based treatment in the management of PPCS. Future prospective study would be beneficial to help further clarify the wider role and recommendations of the multidisciplinary team.

Conflicts of interest

None declared.

Ethics approval

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