Risk Profiles and Appropriate Treatment Therapies for Whiplash Associated Disorders

Synthesis Report

Conducted for the Swiss Insurance Association (SIA)

Also published in the RAND Monograph series

December 2003

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PREFACE

RAND Europe was asked by the Swiss Insurance Association (SIA) to study what treatment strategies are appropriate in dealing with whiplash associated disorders (WAD), with a specific focus on prevention of long-term disability. The main objectives of the study are:

1. Identification of factors related to the event that triggered whiplash as well as to the person that suffers from a whiplash which are conducive to chronic WAD.
2. Determination of what treatments are considered appropriate in specific cases as defined by the conjunction of the identified factors.

This study was conducted by RAND Europe and the Institute of Social and Preventive Medicine (IUMSP) of the University of Lausanne. The research activities were conducted in various stages over the period between May 2000 and June 2003.

It was organized through three linked tasks:

1. A statistical analysis of whiplash insurance cases.
2. A review of the existing literature on whiplash (focusing on prognosis and treatment).
3. An appropriateness panel to gain an insight in clinical expertise on WAD.

For the literature review and the appropriateness panels separate publications have been produced.

This document contains a synthesis of findings from each of the individual tasks. It focuses on the development of risk profiles, the identification of appropriate treatment for WAD, and clinical experience of treatment.. This report should be of interest to the WAD research community, health policymakers, clinical practitioners, decisionmakers and claims handlers in insurance companies, and not in the least, WAD patients.

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EXECUTIVE SUMMARY

This RAND research study used three different methods to examine:

- factors that can predict the development and outcome of chronically disabled whiplash patients,
- types of medical, social and legal treatments that are considered appropriate in specific cases as defined by the conjunction of the identified factors, and
- factors that increase overall costs of whiplash cases.

The study was aimed at capturing what scientific information is available and identifying consensus about what treatment therapies are appropriate in dealing with whiplash victims claiming long-term disability.

RISK PROFILE

Our research was aimed at examining individual factors that could increase the likelihood of a person becoming chronically ill because of WAD. These factors could be detected in the general background characteristics, crash-related factors, medical history or specific symptoms occurring after the accident leading to whiplash. We reviewed the literature and conducted a statistical analysis of over 800 insurance records to inform us about these individual factors. In addition, the statistical analysis was used to also combine the various individual risk factors to come up with a more comprehensive profile. We have distinguished factors in two categories: pre-trauma factors and post-trauma factors.

Pre-Trauma Factors

- **Background factors**

The literature review revealed that many factors can, to a greater or lesser degree, contribute to development of chronic WAD. Factors that are related to the personal characteristics of a WAD patient that were included are female gender and higher age. One study showed that having dependents and not having full-time employment are associated with a slower recovery from whiplash. Marital status was not a significant factor. The statistical analysis of the insurance records was not able to confirm these findings. Gender and language differences seemed to be slight if any. Even though the risk of chronic whiplash seems to have an upward trend with age, a test of the overall age effect was not significant. We also examined the effect of employment and family situation on the medical outcome. Employment status was an important factor. Family status provided less pronounced indications.

- **Pre-Existing Medical Conditions**

We have examined the influence of certain pre-existing medical conditions, both related to previous physical problems. The literature review revealed that pre-existing headache or neck pain could have an impact on the development of (chronic) WAD. The insurance records showed that the quality of the information on pre-existing conditions is low. Much of the information is simply missing. Thus, we were not able to test any relationship as examined in some studies in the literature review.

Post-Trauma Factors

- **Crash-Related Factors**

In the literature review, two studies addressed the effects of crash-related factors on medical outcome. Factors that were associated with slower recovery were: rotated or inclined head position at the moment of impact, unpreparedness of the victim, and rear-end collision. A second study identified the following factors: occupancy in a bus or truck, being a passenger in the car, colliding with a moving object, and being in a head-on or perpendicular collision (i.e. collision head-on or at 90˚) . Passenger position was not a significant factor in the

development of chronic WAD. Both studies concluded that seatbelt use was not a significant factor[1]. In addition, anticipating the rear-end collision could contribute to a better prognosis. In the examination of insurance records, only with respect to passenger status were we able to conclude that the front seat passenger appears most at risk for chronic whiplash injuries.

- **Post-trauma symptoms**

The examination of symptoms is particularly important given the fact that there are no methods available that can easily provide a diagnosis for whiplash. Studies focusing on the prevalence of symptoms in whiplash patients have shown that neck pain and headache were most frequently reported. In addition, many other symptoms were reported, such as pain in shoulders and arms, dizziness, concentration problems, and visual disturbance. In general, the symptoms observed in the cases studies in the insurance records are comparable to the larger body of studies reviewed in the literature. Generally these types of studies, however, do not point to 'required' symptoms or a minimal set of symptoms that should be observable to draw conclusions about the likelihood of chronic WAD.

In our statistical analysis of insurance records we related the occurrence of symptoms with certain outcome or patient characteristics. The first main observation is that number of symptoms and the chronicality of the whiplash are correlated: chronic whiplash patients often have more symptoms, either related to pain or to physical and cognitive indications. The second observation is that the incidence of certain symptoms (pain, physical or cognitive) is related to chronic WAD. A very cautious conclusion is that we found that leg ache, loss of hearing, attention problems, and ringing ears seem to be more prevalent in chronic whiplash cases than in acute cases. However, we do not know in which phase of whiplash these complaints occurred, making it difficult to know whether such factors are predictive or a long-term outcome.

Table 1: Overview of availability and direction of evidence for pre-trauma and post-trauma factors on the development of WAD

Pre-trauma Background factors	Literature Review	Statistical Analysis	Post-trauma medical factors/symptoms	Literature Review	Statistical Analysis
Female gender	★★★★		Impaired neck movement	★★★★	★N
Older age	★★★★	★N	Initial neck pain	★★★★	★N
Having dependents	★★	★N	Initial pain intensity	★★★★	★N
Single	★★		Leg ache	★N	
Area of residence	★★		Back pain	★N	
Level of education	★★		Number of pain factors over 4	★★	
Occupation	★★		Hearing problems	★N	
Net income	★★	★N	Visus problems	★N	
No FT or PT employment	★C		Irritability	★N	
Crash-related factors			Attention problems	★N	
Front seat passenger status	★C		Neuroticiscm score	★★	★N
Use of seatbelt	★★★	★N	Psychological problems	★C	★N
Delta V	★C	★N	Depression	★C	
Inclined or rotated head position	★★	★N	**Legal factors**		
Non awareness of accident	★★★	★N	Lawyer involvement	★N	
Pre-trauma medical factors			Liability insurance	★N	
Small spinal canal width	★★	★N	Litigation status	★★	★N
Pre-trauma headache	★★★★	★N			
Pre-trauma psych. disorders	★★	★N			

★★★★	Much evidence		Increase
★★★	Some evidence		No impact
★★	Little evidence	★C	Contradictory evidence
		★N	No or insufficient evidence

[1] However, people not using a seatbelt can suffer worse fates than whiplash. This implies that the relationship with speed at impact need to be considered.

- **Combination of risk factors**

According to one study in the literature review, the highest degree of predictability of development of chronic whiplash does not result from a single risk factor, but from a combination of several risk factors (impaired neck movement, history of pre-traumatic headache, history of head trauma, higher age, initial neck pain, initial headache intensity, nervousness score, neuroticism score and test score on focused attention).

- **Conclusion risk profile**

We can make two observations based on our analyses of risk factors. The first observation has to do with the significance of focusing on a profile of risk factors rather than on individual factors per se. There is wide variety on what factors and their intensity contribute most to chronic WAD. We are therefore reluctant to list a conclusive list of individual factors that instigate chronic WADs. Constructing a risk profile that can incorporate this diversity and balance various factors with each other is much more powerful.

We developed a prototype prognostic tool that could construct such a risk profile and which was based on the retrospective analysis of insurance records identifying strong and weak predictors of chronic WAD. At this stage, however, both the analysis and the data supporting the analysis have not reached full maturity to effectively implement the prognostic tool in practice. Further analysis and development will be required.

The second observation is with respect to making a clear distinction between risk factors that are pre-existing (such as gender, age, employment, and crash-related) and those risk factors that are the result of the whiplash accident, such as certain occurring symptoms or related to the insurance process or the medical treatment. First, identification of pre-existing risk factors can assist in determining the prognosis of whiplash patients and the seriousness of the patient's condition. Second, identification of process-related factors can provide levers to influence the outcome of the recovery process.

APPROPRIATE TREATMENT

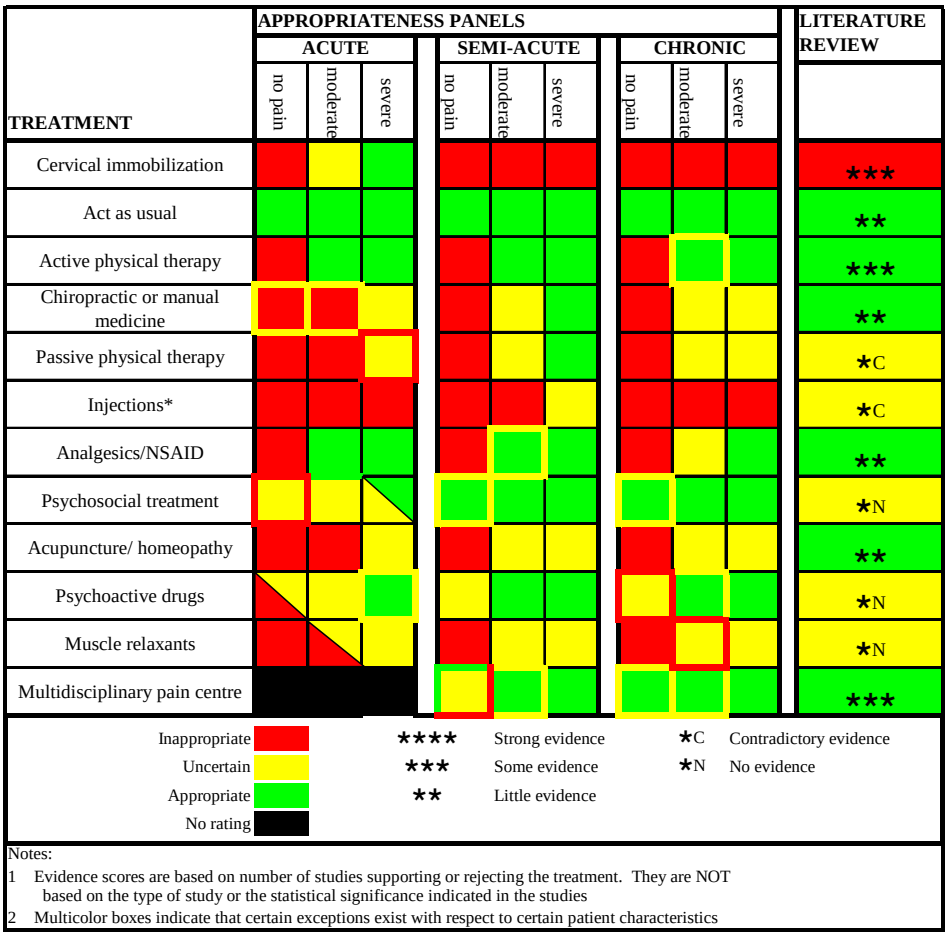
Having examined the evaluated studies in the literature review and the results of the appropriateness panel that was conducted during this study, we can state that there is general agreement about the appropriateness or inappropriateness of a wide range of treatments, including (im)mobilization, chiropractic or manual medicine, pharmacological interventions, acupuncture or homeopathy, and multidisciplinary treatment. The most striking differences between the literature review and the medical panel occur with respect to passive physical therapy and injections, where the panel is more positive about passive physical therapy than the literature and the literature is more positive about injections than the panel.

An important lesson that we learned from the appropriateness panel is to separate WAD patients according to two indicators:

- Duration of complaints
- Degree of physical pain.

Most of the evaluated studies in the literature review considered whiplash patients in general or a very specific category of whiplash patients, but did not discuss the full range of whiplash patients that were included in the panels. However, appropriate treatment can significantly differ based on pain levels and stage of the WAD. The following table provides an overview of the information that we assembled through both methods.

Table 2: Appropriateness of treatment for different therapies



Notes:
1 Evidence scores are based on number of studies supporting or rejecting the treatment. They are NOT based on the type of study or the statistical significance indicated in the studies
2 Multicolor boxes indicate that certain exceptions exist with respect to certain patient characteristics

Our non-medical panel stressed that, in addition to the medical treatment of whiplash patients, the social and legal treatment of those patients is also very important. The non-medical panel indicated some focal points with respect to the management of whiplash patients:

- Focus more on treatment and less on diagnosis.
- Guidance of whiplash patients through the system (case management).
- Improve knowledge dissemination.

Conclusions appropriate treatment

The methods followed during this study have contributed to narrowing down the standards of appropriate care by defining both appropriate and inappropriate treatments and by providing a closer link between appropriateness of treatments and patient characteristics. In general terms, mobilization (and/or 'act-as-usual'), painkillers (NSAIDs, analgesics), multidisciplinary and psychosocial treatment and the use of psychoactive drugs are considered appropriate in many instances. It should be noted that variations in specific patient characteristics (duration of complaints, degree of physical pain) can have an impact on whether a treatment is indeed appropriate. In addition to these treatment options, there is a wide range of uncertain treatment modes. Finally, some treatments are, again, generally considered inappropriate except for specific circumstances. However, it is unclear how inappropriate care affects chronic WAD. We did not find sufficient evidence that people receiving inappropriate care are more prone to chronic WAD.

Given the many uncertain medical treatment options, medical care is only a piece of the puzzle to solving chronic WAD. From the non-medical panel, it is clear that treatment and management strategies can assist in preventing a whiplash case from becoming chronic.

FINANCIAL CONSEQUENCES

Appropriate Treatment vs. Common Treatment

In the statistical analysis we examined what treatment was generally provided. Treatment that was most commonly provided in general[2] shows some dissimilarity to the treatment indicated as appropriate in the medical panel. The type of treatment does not always correspond to the types distinguished in the appropriateness panels with the medical specialists.

The largest and most notable exception is the use of neck collars. Both the most current literature and the opinion of the clinical specialists in the medical panel are generally unfavorable regarding the use of neck collars[3]. However, as recorded in insurance dossiers, practice is that in almost 60% of the analyzed insurance cases, collars were used. The medical specialists considered muscle relaxants at best as uncertain, but never as appropriate. Still, a considerable part of the WAD cases received this type of treatment. If we look at this in more detail, it is noticeable that especially under non-German speaking acute WAD patients the use of muscle relaxants is a considerable 25%. A final considerable difference between appropriate and recorded treatment is psychosocial treatment. The medical specialists considered this to be appropriate in more than half of the examined indications, but only a small fraction has actually received psychosocial treatment.

Cost drivers of WAD cases

The costs of WAD cases can be considered very significant. For the cases that we examined, the total reported costs added to almost CHF 70 million or approximately CHF 94.000 per case[4]. If we examine the figure presented below, much of these costs are related to "rente schaden" or costs disbursed for work disability. It is interesting to see that the actual medical costs are only a fraction (i.e., about 4%) of these disability costs. Another noticeable cost category is the per diem costs that are paid.

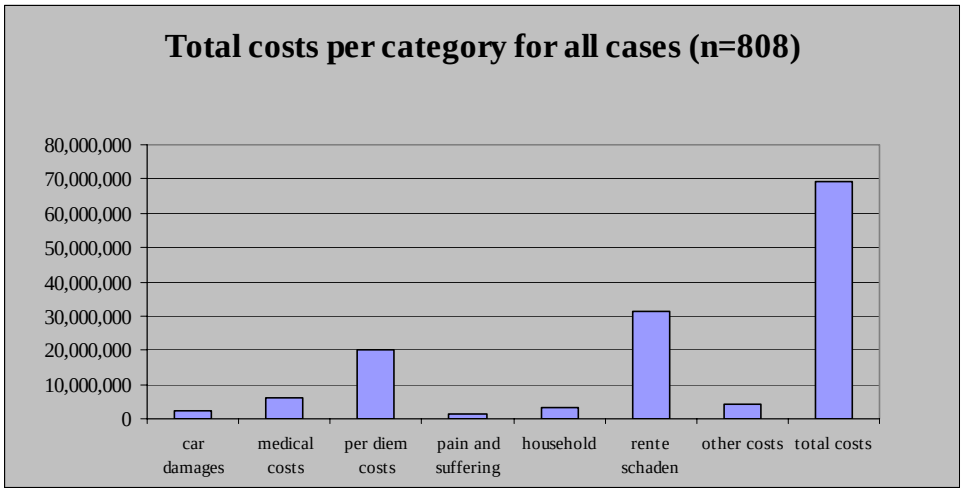


Figure 1: Total costs and costs per distinguished category for all cases included in the statistical analysis

[2] This is based on the data in the insurance records

[3] We used the term cervical immobilization during the appropriateness panels.

[4] The records represented in our sample were biased toward chronic cases; thus the level and types of costs presented here are not the average of all whiplash cases in Switzerland

OVERALL CONCLUSION

With respect to appropriate care, there is still extensive research to be done in combination with diagnostic studies. While it is becoming clearer what is not appropriate, there is still considerable uncertainty about the use of which (combinations of) treatments at what particular phase of whiplash to prevent long-term disability.

The overall interpretation of the appropriateness panels would be to treat specific symptoms in the acute phase, try to apply a wide series of treatments in the semi-acute phase, and attempt to treat person-related characteristics in the chronic phase which could vary from pain management to psychosocial treatment to non-medical interventions as labor or social training.

At the same time, there are clear indications that there is room for improvement regarding the actual care that is given and (financially) supported. Collars and muscle relaxants are two broadly applied examples of inappropriate care that is still widely provided. We were not able to distinguish among specific patients and the specific care provided, but we suspect that there is potential for improvement in a substantial number of cases for specific instances. Better implementation of the currently available knowledge will improve treatment and reduce costs. Examples of better implementation are the development of stages, long-term treatment plans, early attention to patients that may forestall later costs, and the reduction of costs by reducing the incidence of inappropriate treatment.

1. INTRODUCTION

The purpose of this concluding chapter is to analyze and synthesize information from the literature review, statistical analysis, and appropriateness panels in order to provide recommendations for policy on how to deal with whiplash claims. Each of the methods applied during this study and reported on in the previous chapters provides relevant information to answer a series of research questions categorized in three main groups. The synthesis will focus on treatments of whiplash, efficacy and utilization of treatments and prognostic factors (both crash-related and person-related) that can help distinguish between those WAD cases that are likely to become chronic and those that are not.

This synthesis chapter will highlight differences and similarities in the findings from the different methods based on a discussion of the following research questions:

- What are the factors related to the event that triggered whiplash as well as to the person that suffered whiplash which are conducive to claims for long-term disability payment?
- What medical, social and legal treatments are considered appropriate in specific cases as defined by the conjunction of the identified factors?
- What factors increase overall costs of whiplash cases in terms of presently (in)appropriate treatment and other process-related factors?

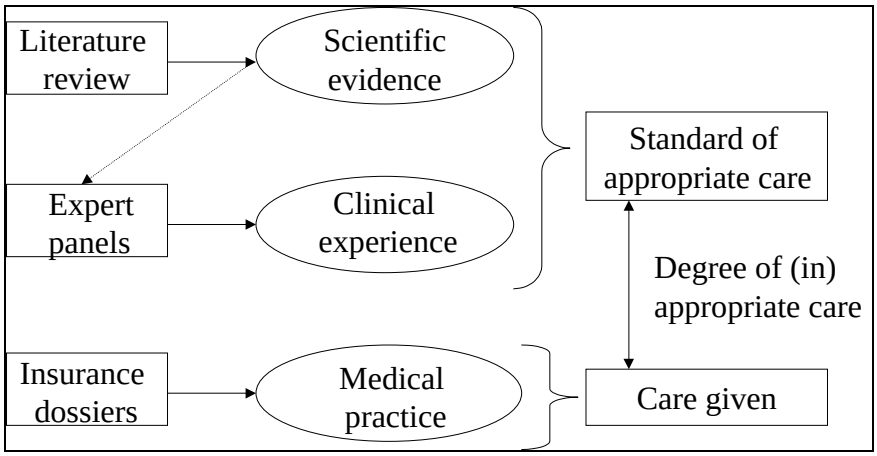


Figure 2: Use of methods to determine standard and degree of appropriate care

The methods that we applied during this study have provided output of different scope and power. The literature review encompassed an extensive number of studies highlighting the various elements (treatment, risk factors, diagnoses) of whiplash. This provided a broad picture of indications and possibilities of evidence regarding WAD. In principle, the literature review should have contributed to the most powerful outcome. However, the quality and the often narrow foci of these studies did not result in an overwhelming accumulation of evidence.

The appropriateness panel provided an applied medical perspective to the WAD elements. We assembled medically trained people from various disciplines to provide a broad picture of WAD and its appropriate treatment that could prevent chronic whiplash. The down side of this method is its dependability on a limited number of people and the focus on clinical experiences rather than scientific evidence through RCT.

Finally, we conducted a statistical analysis of a considerable set of insurance records. The set was large enough to be able to draw statistically significant and representative relationships between relevant factors. However, the quality of the information (either though coding or the actual data contained in the records) and the selection of cases was conducted under

difficult circumstances. In addition, many variables were incorporated in the coding form. This resulted in a poor data distribution for some variables. Because of this structure, the statistical analysis has been able to highlight issues and provide indications of differences between actual and desirable practices, but we should caution people to use the results in a widespread manner.

2. RISK PROFILE

The first research question posed is about the risk profile of a typical whiplash patient. This question is complex to answer not in the least because of the very diverse nature of WADs. It is therefore very difficult to speak about a typical whiplash patient, even less about a general risk profile. Our research was aimed at examining individual factors that could increase the likelihood of a person becoming chronically ill because of WAD. These factors could be detected in the general background characteristics, crash-related factors, medical history or specific symptoms occurring after the accident leading to whiplash. We used the literature review and the statistical analysis to inform us about these individual factors. In addition, the statistical analysis was used to combine the various individual risk factors to come up with a more comprehensive profile.

2.1. BACKGROUND FACTORS

The literature review revealed that many factors can, to a greater or lesser degree, contribute to development of chronic WAD. Factors that are related to the personal characteristics of a WAD patient that were included are female gender and higher age.

The statistical analysis of the insurance records was not able to confirm these findings. Sex and language differences seemed to be slight if any . Non-German speaking females seemed to have the lowest risk of any sex/language category but that difference was not significant[5]. Even though the risk of chronic whiplash seems to have an upward trend with age, a test of the overall age effect was not significant. In addition, we also examined the role of nationality (i.e., Swiss vs. non-Swiss) based on perceptions that insurers had. However, nationality did not seem to be an important factor given the other available predictors of chronic whiplash.

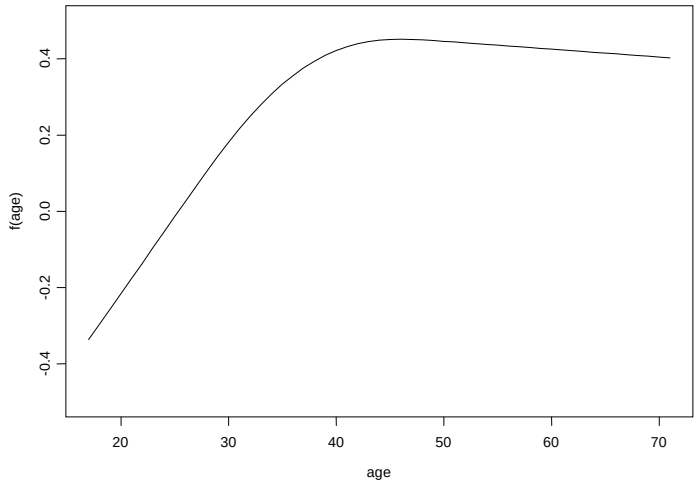


Figure 3: Relationship between Age and the Log-odds of Chronic Whiplash

Employment status/social network

In the literature review, one study (Harder, 1998) focused on the effects of social support networks and employment situation on medical outcome. This study showed that having dependents and not having full-time employment are associated with a slower recovery from whiplash. Marital status was not a significant factor.

[5] We use the term "significant" throughout this section meaning "statistically significant", which implies that observed differences are not the result of randomness in sampling the cases but based on different distribution of variables and factors.

In the statistical analysis, we examined the effect of employment and family situation on the medical outcome. Employment status was an important factor. While there was no real difference between full time and part time employees, the employed individuals were much less likely ($p < 0.02$) to report chronic whiplash than others (housewife, others, and unknown). Subjects with other employment such as side jobs, unemployed, unable to work, or on a pension were at significantly higher risk than full time employees ($p = 0.03$) and part time employees ($p = 0.01$).. The odds that a housewife reported chronic whiplash was about 1.5 times greater than the full time employed subjects. This difference was, however, not significant. Each of these observations took account of age-related differences with employment situation.

Family status provided less pronounced indications. Single individuals had a lower risk of chronic whiplash, not much less than married ($p = 0.44$), nor significantly less than separated/divorced ($p = 0.71$) nor the "other's" ($p = 0.32$).

2.2. CRASH-RELATED FACTORS

In the literature review, two studies (Sturzenegger, 1994; Harder, 1998) studied the effects of crash-related factors on medical outcome. Factors that were associated with slower recovery from whiplash in Sturzenegger's study were: rotated or inclined head position at the moment of impact, unpreparedness of the victim, and rear-end collision. Harder's study identified the following factors: occupancy in a bus or truck, being a passenger in the car, colliding with a moving object, and being in a head-on or perpendicular collision (i.e. collision head-on or at 90˚) . Sturzenegger's study, however, indicated that passenger position was not a significant factor in the development of chronic WAD. Both studies concluded that seatbelt use was not a significant factor[6]. In addition, anticipating the rear-end collision could contribute to a better prognosis.

In the examination of insurance records, we tried to look at the correlation of several crash-related factors, among which passenger status, delta V, anticipation, and use of seat belt. For many of these factors, information was not sufficient or of enough quality to provide any detailed analysis. Only with respect to passenger status were we able to conclude that the front seat passenger appears most at risk for chronic whiplash injuries, more than the driver ($p = 0.06$) but not significantly more than the backseat passenger ($p = 0.59$).

2.3. MEDICAL FACTORS

We will discuss physical or cognitive symptoms and applied treatment strategies in the next section of this chapter. Here, we have examined the influence of certain pre-existing medical conditions, both related to previous physical problems, such as neck pain, headache and migraines, as well as other cognitive or psychological conditions. The literature review revealed that pre-existing headache or neck pain could have an impact on the development of (chronic) WAD.

The insurance records showed that the quality of the information on pre-existing conditions is low. Much of the information is simply missing. Clearly, this has for a large extent to do with the confidentiality of medical information and the fact that claimants do not wish to disadvantage their own position by providing potentially harmful information. Thus, we were not able to test any relationship as examined in some studies in the literature review.

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[6] However, people not using a seatbelt can suffer worse fates than whiplash. This implies that the relationship with speed at impact need to be considered.

2.4. INSURANCE-RELATED FACTORS

Factors related to an insurance claims process were generally not examined in studies reviewed in the literature.

The statistical analysis of the insurance records did consider such factors as number of people involved in the insurance process, type of insurance, and speed of response of the insurance companies to the initial claim. Most factors did not demonstrate any effect on the development of WAD. However, claims issued under a liability insurance greatly increased the odds of reporting chronic whiplash. The odds of chronic whiplash were 6.5 times greater for those subjects with liability than for those without (p = 0.81).

Table 3: Overview of availability and direction of evidence for pre-trauma and post-trauma factors on the development of WAD

Pre-trauma Background factors	Literature Review	Statistical Analysis	Post-trauma medical factors/symptoms	Literature Review	Statistical Analysis
Female gender	★★★★		Impaired neck movement	★★★★	★N
Older age	★★★★	★N	Initial neck pain	★★★★	★N
Having dependents	★★	★N	Initial pain intensity	★★★★	★N
Single	★★		Leg ache	★N	
Area of residence	★★		Back pain	★N	
Level of education	★★		Number of pain factors over 4	★★	
Occupation	★★		Hearing problems	★N	
Net income	★★	★N	Visus problems	★N	
No FT or PT employment	★C		Irritability	★N	
Crash-related factors			Attention problems	★N	
Front seat passenger status	★C		Neuroticiscm score	★★	★N
Use of seatbelt	★★★	★N	Psychological problems	★C	★N
Delta V	★C	★N	Depression	★C	
Inclined or rotated head position	★★	★N	**Legal factors**		
Non awareness of accident	★★★	★N	Lawyer involvement	★N	
Pre-trauma medical factors			Liability insurance	★N	
Small spinal canal width	★★	★N	Litigation status	★★	★N
Pre-trauma headache	★★★★	★N			
Pre-trauma psych. disorders	★★	★N			

★★★★	Much evidence		Increase
★★★	Some evidence		No impact
★★	Little evidence	★C	Contradictory evidence
		★N	No or insufficient evidence

2.5. COMBINATION OF RISK FACTORS

According to one study in the literature review (Radanov *et al.*, 1996), the highest degree of predictability of development of chronic whiplash does not result from a single risk factor, but from a combination of several risk factors (impaired neck movement, history of pre-traumatic headache, history of head trauma, higher age, initial neck pain, initial headache intensity, nervousness score, neuroticism score and test score on focused attention). However, other studies give different results and no study has shown convincing predictability of development of chronic WAD.

Our statistical analysis applied two techniques to determine probability ratios of chronic whiplash. An “independence (or naive) Bayes classifier” technique was used to establish a risk profile of chronic whiplash. At this stage, however, both the analysis and the data supporting the analysis have not reached full maturity to effectively implement the prognostic tool in practice. Further analysis and development will be required. Here we describe our approach and the potential applicability if further development has taken place.

The basic set up is that the presence or absence of each investigated factor are points in favor or against chronic whiplash. Some variables are important on their own (mostly insurance-related factors). Added together several less important variables can also male a large contribution to total evidence. After obtaining estimates of the probabilities we can construct an evidence balance sheet for newly observed cases[7]. All known factors are used in a "balance sheet of weights of evidence"[8]. Once new information becomes available, it can be integrated in a new balance sheet. The balance can be converted to a probability of chronic whiplash. The following table provides an example of this method.

Table 4: Example evidence balance sheet

Evidence in favor of chronic[9]		**Evidence in favor of acute**	
Tingle	+22	Prior	-199
Depressed	+16	No leg pain	-2
Attention problem	+61	No hearing loss	-7
Insurance company = DMAB	+128	Marital status: Widow	-25
Lawyer	+174	French speaking	-28
Total positive evidence	+401	Total negative evidence	-261
Total evidence		+140	
Probability of chronic whiplash		80%[10]	

This method has two main benefits. First we can easily see the differential effect of the presence or absence of certain indicators. For example, the absence of hearing problems slightly favors the acute whiplash outcome. On the other hand, if there is evidence of hearing problems this places a lot of evidence in favor of a chronic whiplash outcome. In general it seems that the absence of certain symptoms says little, while the presence of a symptom carries a lot of information. Secondly, the absence of a symptom is handled differently than missing or unknown information about the symptom. All missing indicators contribute 0 to the total weight of evidence.

The total evidence is then translated into a probability that a case will turn into a chronic case. The following table converts these evidence scores into probability:

[7] For an overview of all the weight of evidence calculated in the statistical analysis of the approximately 800 insurance records, see Annex A.

[8] Oftentimes in automated medical diagnosis, missing data is common. Even though we may be interested in 20 different pieces of evidence, we may information on only three features. A naïve Bayes classifier can still handle such a scenario without modification.

[9] A positive weight implies that the state of is evidence in favor of a chronic whiplash and a negative weight is evidence in favor of acute.

[10] The conversion of total evidence in probability is done using:

$$p = \frac{1}{1 + \exp(-\text{Total WOE})/100}$$

Table 5: Conversion from weight of evidence to probability

Probability	Total weight of evidence
10%	-220
20%	-139
30%	-85
40%	-41
50%	0
60%	41
70%	85
80%	139
90%	220

The technique can be used for each new (or if desirable: old) whiplash case. All the information that is available about such a case should be scored according to the evidence that is available[11]. At any given moment, filling these scores into a balance sheet as presented above will ultimately provide an indication of the risk profile of the whiplash case.

2.6. CONCLUSION

We can make two observation based on our analyses of risk factors. The first observation has to do with the significance of focusing on a profile of risk factors rather than on individual factors per se. There is wide variety on what factors and their intensity contribute most to chronic WAD. We are therefore reluctant to list a conclusive list of individual factors that instigate chronic WADs. Constructing a risk profile that can incorporate this diversity and balance various factors with each other is much more powerful. We developed a prototype prognostic tool that can construct such a risk profile and which is based on the retrospective analysis of insurance records identifying strong and weak predictors of chronic WAD.

The second observation is with respect to making a clear distinction between risk factors that are pre-existing (such as gender, age, employment, and crash-related) and those risk factors that are the result of the whiplash accident, such as certain occurring symptoms or related to the insurance process or the medical treatment. The former category is easier to identify as they often have a very factual character. The latter category is more difficult to determine. For example, is the symptom of leg ache a direct result of the accident mechanism or is the consequence of suffering other related pains or is the result of the chronification of WADs. The distinction is relevant for two purposes. First, identification of pre-existing risk factors can assist in determining the prognosis of whiplash patients and the seriousness of the patient's condition. Second, identification of process-related factors can provide levers to influence the outcome of the process.

The combination of these factors prevents us to present an undisputed risk profile at this moment. The statistical analysis provided a first attempt in setting this up. However, quality of the information in our statistical analysis is too uncertain to determine the specific risk that certain factors carry. The knowledge to make explicit distinction between factors that are pre-existent or result of the WAD process is not yet empirically based.

[11] see the annex to these conclusions for more elaborate evidence scores.

3. TREATMENT AND SYMPTOMS

3.1. APPROPRIATE TREATMENT

Both literature review and the participants in the appropriateness panel have assessed a wide variety of treatments. Most studies discussed in the literature review did not focus on treatments in various stages but primarily reviewed treatment during the acute phase. In addition, no other specific personal background or crash-related factors were taken into consideration in assessing the effectiveness and/or appropriateness of treatments. The appropriateness panel was given specific patient characteristics, such as symptoms, past medical history, and social network. However, the results of the panel showed that prognosis based on socio-demographic characteristics does not have a large impact on treatment decisions. The effect of the degree of cognitive and vegetative dysfunction was also small. The panel results showed that treatment decisions are mostly influenced by the degree of physical pain and time since the accident. Finally, the participants in the non-medical panel provided more anecdotal information about considering certain types of medical treatments.[12]

3.2. THE MOST APPROPRIATE TREATMENTS ACCORDING TO THE MEDICAL PANEL

The table below indicates which treatments are most appropriate according to the medical panel. The first column presents the degree to which treatments are considered to be appropriate for all types of whiplash patients included in the rating form. The second column presents the same information for whiplash patients with moderate or severe physical pain. We present this table because many treatments were rated inappropriate for patients without physical pain, which is generally logical, but biases the overall valuation of the treatment.

Table 6: Appropriateness of different treatment strategies

	% appropriate indications	% appropriate indications (excl. patients without physical pain)
Act as usual	100	100
Active physical therapy	64.4	96.7
Multidisciplinary pain referral	63	83.3
Psychosocial treatment	60	73.3
Analgesics/NSAIDs	57.8	86.7
Psychoactive drugs	46.7	70
Chiropractic/manual medicine	13.3	20
Passive physical therapy	13.3	20
Cervical immobilization	11.1	16.7
Injections	0	0
Acupuncture/homeopathy	0	0
Muscle relaxants	0	0

For most treatments, the percentage of appropriate indications increases by 50% when patients without physical pain are considered. However, the appropriateness of psychosocial treatment and multidisciplinary pain referral increases by less than 50%, implying that these treatments are also appropriate for some patients without physical pain. Psychosocial treatment is recommended for no-pain patients with severe cognitive and vegetative

[12] In fact, the evaluation of medical treatments was not the major objective of the non-medical panel. However, their experience with the treatments was used as a valuable information source.

dysfunction, and for no-pain patients with moderate cognitive and vegetative dysfunction and a poor prognosis. Multidisciplinary pain referral is recommended for no-pain patients with severe cognitive and vegetative dysfunction and a poor prognosis in the semi-acute phase and for no-pain patients with severe cognitive and vegetative dysfunction in the chronic phase.

Comparison of results of the literature review and the medical panel

If we compare the evaluated studies in the literature review with the results of the appropriateness panel, there is general agreement about the effectiveness or ineffectiveness of a wide range of treatments, including (im)mobilization, chiropractic or manual medicine, pharmacological interventions, acupuncture or homeopathy, and multidisciplinary treatment. The most striking differences between the literature review and the medical panel occur with respect to passive physical therapy and injections, where the panel is more positive about passive physical therapy than the literature and the literature is more positive about injections than the panel. A treatment by treatment comparison results in the following listing:

- **Act as usual**: 'Act as usual treatments' were not considered in any of the studies of the literature review. However, they were explicitly included by the participants to the medical appropriateness panel. In the definition of this medical panel, 'acting as usual' is the explicit prescription of the care-giver that the patient continues, to the extent possible, normal activity. This was considered to be appropriate for all types of whiplash patients.
- **Immobilization vs. mobilization/:** Both the literature review and the medical panel conclude that immobilization of the cervical spine is generally ineffective. The literature indicates that activation has beneficial effects over immobilization. This is confirmed by the medical panel which indicates that it is always appropriate for whiplash patients to 'act as usual' and that it is usually appropriate to undergo active physical therapy. Active physical therapy is only contraindicated for patients without pain.
- **Multidisciplinary treatment:** Both the literature review and the medical panel indicate that multidisciplinary treatment is generally effective for whiplash patients in the semi-acute and chronic phase.
- **Psychosocial treatment**: The literature review did not identify any articles on the appropriateness of psychosocial treatment for WAD. Therefore, it is not possible to compare the results of the medical panel with the literature review. As can be seen in Table 1, psychosocial treatment was considered effective in a majority of cases.
- **Pharmacological interventions (analgesics/NSAIDs):** Both the literature and the medical panel conclude that pharmacological interventions focused on reduction of physical pain might be appropriate. The literature shows some evidence for the effectiveness of high-dose methylprednisolone (a corticosteroid) and tenoxicam (an NSAID). The medical panel believes that analgesics/ NSAIDs are generally appropriate for whiplash patients with moderate or severe pain in the acute or semi-acute phase and for patients with severe pain in the chronic phase.
- **Pharmacological interventions (psychoactive drugs):** The literature review does not include any studies focusing on the effectiveness of psychoactive drugs. The medical panel is generally uncertain about the appropriateness of these drugs for most whiplash patients. However, for patients with moderate or severe pain in the semi-acute or chronic phase the medical panel believes psychoactive drugs are appropriate.
- **Chiropractic or manual medicine:** Both the results of the literature review and the results of the medical panel indicate that chiropractic and manual medicine are of uncertain benefit to whiplash patients. The literature contains some evidence for the effectiveness of chiropractic treatment and no evidence for the effectiveness of a single manipulation. The medical panel believes that the effectiveness of this type of treatment is generally uncertain. Chiropractic or manual medicine is only appropriate for patients with severe pain in the semi-acute phase of whiplash.
- **Passive physical therapy:** The medical panel was slightly more positive about the possible effectiveness of passive physical therapy than the literature review. Whereas the

literature (based on one study) indicates that this type of treatment is not effective, the medical panel indicates that passive physical therapy **is** appropriate for whiplash patients with severe pain in the semi-acute phase, and **might be** beneficial for patients with severe pain in the acute phase, with moderate pain in the semi-acute phase and moderate and severe pain in the chronic phase.

- **Injections:** The literature is somewhat more positive about the possible effectiveness of injections than the medical panel. The panel believes injections are inappropriate for all whiplash patients, with the possible exception of patients with severe pain in the semi-acute phase for whom the effectiveness of injections is uncertain. The literature review included four studies on injections, of which three contain evidence for the effectiveness of injections in the semi-acute or chronic phase.
- **Acupuncture/homeopathy:** Both the literature review and the medical panel indicate that alternative treatments might be beneficial for whiplash patients. The literature reviews includes one study showing some effectiveness of acupuncture, and the medical pain indicates that the effectiveness of alternative treatment is uncertain for patients with moderate and severe pain. For patients without pain, acupuncture and homeopathy are considered to be inappropriate. The non-medical panel added that the medical panel might have underestimated the effectiveness of alternative treatments.
- **Pharmacological interventions (muscle relaxants):** The literature review does not include any studies focusing on the effectiveness of muscle relaxants. The medical panel generally indicates that muscle relaxants are inappropriate for whiplash patients with no pain or moderate pain and a good prognosis in the acute phase. For more severe patients, the medical panel believes that muscle relaxants are of uncertain value.
- **Surgery:** The literature contains evidence for the effectiveness of surgery in specific groups of whiplash patients. As the medical panel only focused on the appropriateness of treatments for patients without objective physical signs of whiplash, it did not rate surgery. Generally, surgery is only performed in whiplash patients with an objective physical source of pain.

Often the results of the appropriateness panel are more specific than the conclusions drawn from the literature. The conducted studies often focus on whiplash patients in general or on a very specific category of whiplash patients, but do not discuss the full range of whiplash patients that were included in the panels. In addition, the medical panel rated the appropriateness of some treatment strategies for which no articles were present in the literature.

The medical panel focused on treatment for palliative purposes; pain management was one of the most essential ones. Treatment, especially in the chronic stages, never had cure of the disorders as an objective. Perhaps therefore, the panelists seem to restrict their judgment of appropriateness to those types of treatments that have proven themselves in the past and thus tend to be mainstream and traditional. Treatments such as injections, electrotherapy, and acupuncture (which have at least ambiguous findings in the literature) were often assessed less appropriate. The non-medical panel provided a much broader range of possibly appropriate treatments, including therapies such as craniosacral therapy or Alexander technique which are alternatives to more common physiotherapy. Neither the literature review nor the appropriateness panel considered these types of treatments. Therefore, only additional clinical research can validate or invalidate these types. After such research, conclusions may be drawn about other forms of treatments.

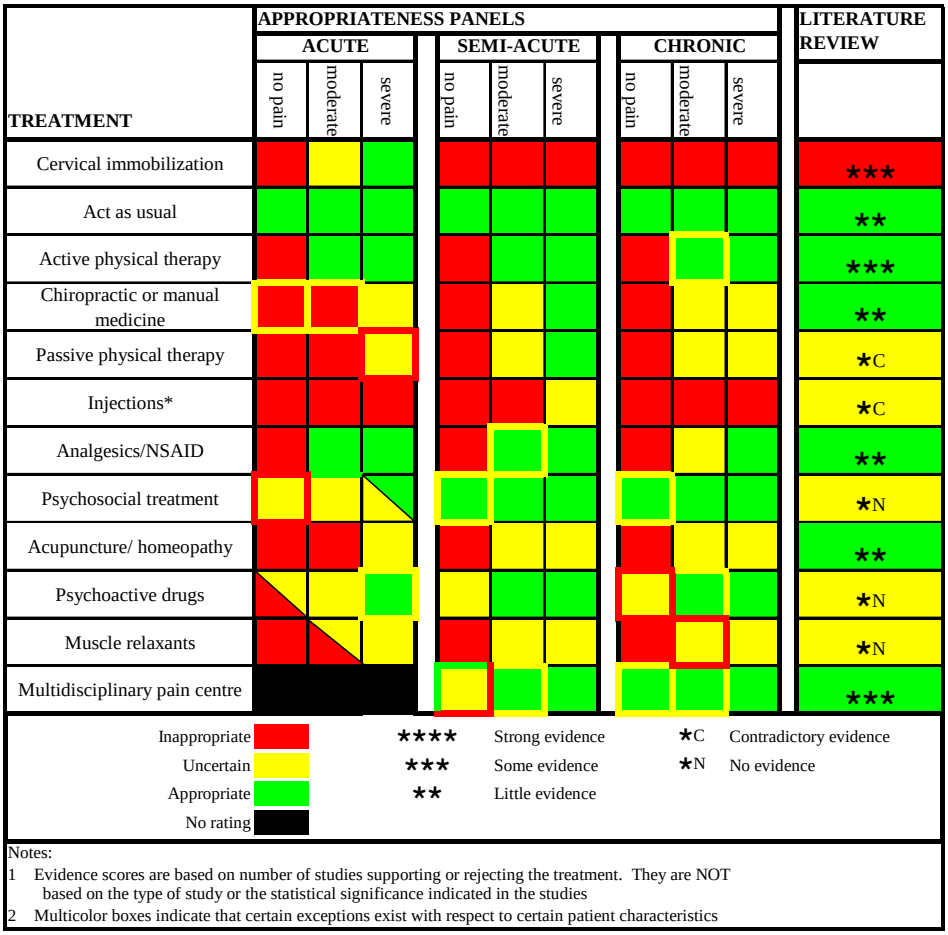
The non-medical panel stressed that, in addition to the medical treatment of whiplash patients, the social and legal treatment of those patients is also very important. The non-medical panel indicated some focal points with respect to the management of whiplash patients:

- Focus more on treatment and less on diagnosis: Currently, whiplash patients have to undergo many diagnostic tests in an effort to objectify their complaints, and to

'prove' that they suffer from WAD. Instead, the patient should be taken seriously and the focus should be on treating the patient and offering the patient an environment of trust and security.

- Guidance of whiplash patients through the system: As said before, the treatment of whiplash patients should not only focus on medical, but also on social and legal aspects. It is known that conflict situations may have a detrimental effect on patients. A case manager could play an important role in avoiding conflicts by coordinating all the problems whiplash patients are confronted with.
- Improve knowledge dissemination: It can be concluded from our project that not all care givers are sufficiently knowledgeable about WAD, sometimes leading to inappropriate medical treatment and to insufficient provision of information to the patients. Both the care givers and the patients will benefit from better distribution of the currently available knowledge and improved education and training.

Table 7: Appropriateness of treatment for different therapies



Notes:
1 Evidence scores are based on number of studies supporting or rejecting the treatment. They are NOT based on the type of study or the statistical significance indicated in the studies
2 Multicolor boxes indicate that certain exceptions exist with respect to certain patient characteristics

3.3. COMMON SYMPTOMS IN WAD

Next to examining appropriate treatment, the different aspects of this study also examined actual symptoms occurring in whiplash cases and common treatment strategies. The examination of symptoms is particularly important given that the literature review showed no commonly accepted diagnostic methods (such as MRI, X-Ray) that can indicate organic conditions resulting in WAD. The examination of diagnostic methods was thus left out of the appropriateness panel and the statistical analysis of insurance records. By lack of a diagnostic method, whiplash is often diagnosed based on frequently occurring symptoms. Here both the literature review and the insurance dossiers provide information.

The literature review emphasized the prevalence of certain symptoms; that is, what common symptoms are there among different whiplash cases? After a whiplash injury, patients have reported a wide range of physical, cognitive, and psychological symptoms. Studies focusing on the prevalence of symptoms in whiplash patients have shown that neck pain and headache were most frequently reported. In addition, many other symptoms were reported, such as pain in shoulders and arms, dizziness, concentration problems, and visual disturbance. The studies included in the literature review show a wide range in the reported prevalence of symptoms, e.g. the reported prevalence of headache varies from 27% to 78% of whiplash patients.

The statistical analysis in our study also contributed to observing the prevalence of symptoms. The following table shows the occurring symptoms in order of incidence/prevalence.

Table 8: Symptoms in WAD patients, by gender and total

Symptoms	Total	Symptoms	Total
Neck pain	85.69%	Vomiting	9.53%
Limited motion	69.33%	Other pain	8.40%
Headache	53.39%	Attention problems	8.38%
Shoulder pain	37.28%	Visus problems	5.76%
Dizziness	29.45%	Irritability	3.04%
Nausea	22.49%	Leg ache	2.52%
Arm ache	19.08%	Ringing in ears	2.47%
Backache	13.32%	Loss of hearing	2.17%
Tingle	13.04%	Loss of affection	1.55%
Depression	10.70%	Personality problems	1.35%
Fatigue	9.95%	Memory problems	0.0%

In general, the symptoms observed in the cases studies in the insurance records are comparable to the larger body of studies reviewed in the literature.

Generally these types of studies, however, do not point to ‘required’ symptoms or a minimal set of symptoms that should be observable to draw conclusions about the likelihood of chronic WAD. The problem with this information is that it only allows for the formulation of minimal guidelines for detecting extensive or chronic specific whiplash cases. In our statistical analysis of insurance records we were able to highlight a slightly more useful perspective as we related the occurrence of symptoms with certain outcome or patient characteristics.

As the following figure indicates, the first main observation is that number of symptoms and the chronicality of the whiplash are correlated: chronic whiplash patients often have more symptoms, either related to pain or to physical and cognitive indications.

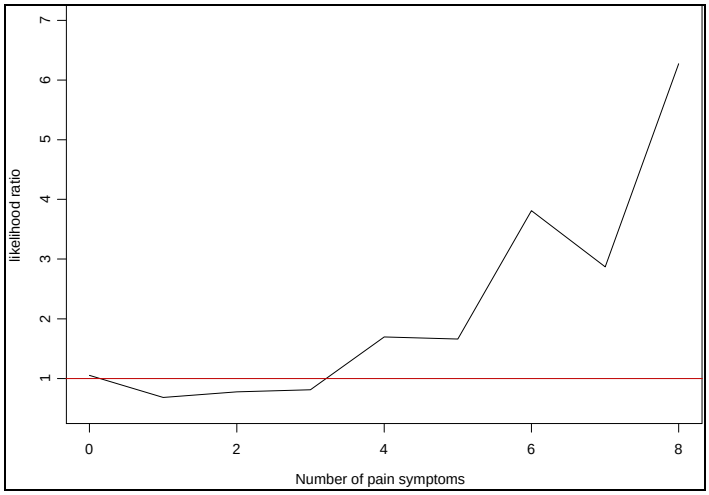


Figure 4: Likelihood ratio comparing the frequency of chronic to acute subjects by number of pain symptoms

The horizontal axis in Figure 4 indicates the number of pain symptoms. The vertical axis is the likelihood ratio, the probability that a subject has a certain number of pain symptoms given that they had chronic whiplash divided by the probability of having that many pain symptoms given that they had acute whiplash,

$$P(\#\text{ symptoms} = x \mid \text{chronic}) / P(\#\text{ symptoms} = x \mid \text{acute}).$$

The horizontal line at 1 indicates the point at which it is equally likely for chronic and acute whiplash subjects to have the same number of symptoms. The figure shows that the frequency of up to three pain symptoms is not different from acute to chronic whiplash subjects. However, chronic whiplash sufferers are approximately twice as likely to have 4 or 5 pain symptoms and 4 times more likely to have six pain symptoms ($p = 0.013$)[13].

The second observation is that the incidence of certain symptoms (pain, physical or cognitive) is related to chronic whiplash. A very cautious conclusion is that we found that leg ache, loss of hearing, attention problems, and ringing ears seem to be more prevalent in chronic whiplash cases than in acute cases. It should be noted (as can be seen in Table 8) that none of these symptoms occur very often in the whiplash cases that were analyzed; in only 5% of the cases attention problems were documented, for leg ache this was just 1%. In addition, the establishment of a Bayesian risk profile can assist in determining the combination of factors that contribute greatly to the probability of chronic whiplash.

3.4. APPROPRIATE TREATMENT VS. COMMON TREATMENT

Although both treatment of WADs and the occurrence of specific symptoms have been studied in some detail, little information is available about appropriateness of treatment in the case of certain conditions. In general, treatment is oriented toward the entire whiplash syndrome. It is obvious that certain types of symptoms, such as cognitive symptoms, are cause for specific types of treatments, such as the use of psychoactive drugs or psychotherapy. However, within certain types of symptoms no distinction is made or no preferred selection of treatment is identified.

[13] The (pain) symptoms are those symptoms that were listed in our dossier coding form. Any symptom that was scored in that form was taken into consideration in conducting the logistic regression. There was no grouping of symptoms (e.g., upper vs. lower part of the body), meaning that each symptom was scored as a separate symptom independent of the nature of the particular symptom.

In the statistical analysis we examined what treatment was generally provided and, additionally, distinguished among treatment that was provided across different outcome groups (acute vs. chronic) and language groups (German vs. non-German) in Switzerland. Treatment that was most commonly provided in general[14] shows some dissimilarity to the treatment indicated as appropriate in the medical panel. The type of treatment does not always correspond to the types distinguished in the appropriateness panels with the medical specialists.

Table 9: Use of treatment as percentage of total sample

TREATMENT	Female	Male	Total
Analgesics/NSAID[15]	85%	72%	79.7%
Neck collar	63%	48%	56.9%
Physiotherapy	52%	36%	45.5%
Massage	16%	9%	13.2%
Muscle relaxant	10%	8%	9.2%
Strength therapy	8%	4%	6.4%
Posture training	7%	2%	5.0%
Psychosocial treatment	6%	4%	5.2%
TENS	4%	6%	4.8%

The largest and most notable exception is the use of neck collars. Both the most current literature and the opinion of the clinical specialists in the medical panel are generally unfavorable regarding the use of neck collars[16]. However, as recorded in insurance dossiers, practice is that in almost 60% of the analyzed insurance cases, collars were used. While the use of neck collars is not always inappropriate[17], it is unlikely that the sample of insurance records contained so many patients with characteristics for the appropriate use of collars. Additional information about the actual use is rather restricted because the information retrieved from the insurance records contained insufficient detail on this specific issue.

The medical specialists considered muscle relaxants at best as uncertain, but never as appropriate. Still, a considerable part of the WAD cases received this type of treatment. If we look at this in more detail, it is noticeable that especially under non-German speaking acute WAD patients the use of muscle relaxants is a considerable 25% (see below, Table 10).

[14] This is based on the data in the insurance records

[15] It is questionable whether information in insurance records or the coding thereof were always capable of distinguishing analgesics from NSAIDs. While there are theories that certain NSAIDs might have beneficial curative effects, it is unlikely that differences in clinical practice have been caused by differences in opinion about this. Instead, it could be argued that the Analgesics and NSAIDs categories should be grouped together. In that case, the notable differences between Swiss-German and Swiss-non-German tend to disappear.

[16] We used the term cervical immobilization during the appropriateness panels.

[17] The medical panel considered it appropriate in less than 20% of the indications, and then largely for pain management.

Table 10: Different types of treatment, by language group

TREATMENT	Swiss non- German	Swiss-German
Analgesics/NSAID	82.5	79.7
Neck collar	49.1	59.4
Physiotherapy	36.1	47.9
Massage	9.8	14.9
Strength	3.3	8.1
Posture training	1.3	6.5
Convalescent	3.6	6.4
Psychosocial treatment	4.2	5.8
TENS	2.2	5.5
Muscle relaxant	26.1	4.9

A final considerable difference between appropriate and recorded treatment is psychosocial treatment. The medical specialists considered this to be appropriate in more than half of the examined indications, but only a small fraction has actually received psychosocial treatment. There are two likely explanations for this. First of all, a WAD patient can consider psychosocial treatment as a diversion of the perceived patient image and has thus difficulty acknowledging the relevance or effect of psychosocial treatment. Second, given the fact that the occurrence of psychological factors can disadvantage a plaintiff in the legal process, there might be a considerable underreporting error in the numbers of Table 9. In the first case, considerable numbers of WAD patients could be deprived of appropriate treatment; in the second case, patients do not seek remuneration of treatment at the insurance companies. If the legal context would change, this could lead to considerable increased costs for insurance companies.

There are interesting differences in applied treatment across chronic and acute, in combination with the German and non-German distinction. There is clear higher usage of treatment across German-speaking WAD patients, both acute and chronic. Especially noticeable in the group of chronic German-speaking patients is the use of collars, massage, strength training, and psychosocial treatment. With respect to the latter treatment, this is much more according to what was found appropriate in the medical panel.

Table 11: Types of treatment for WAD, by outcome by language group

Whiplash type	Acute		Chronic	
Language	Swiss non-German	Swiss German	Swiss non-German	Swiss German
Treatment				
Analgesics	82	80	85	78
Neck collar	48	58	55	67
Physiotherapy	34	47	48	53
Massage	8	11	20	37
Strength	3	6	5	20
Posture	1	6	3	9
Tens	1	5	9	8
Convalescent	1	4	18	20
Psych	4	4	5	16

3.5. CONCLUSIONS

The methods followed during this study have contributed to narrowing down the standards of appropriate care by defining both appropriate and inappropriate treatments. In general terms, mobilization (and/or 'act-as-usual'), painkillers (NSAID, Analgesics), multidisciplinary and psychosocial treatment and the use of psychoactive drugs are considered appropriate in many

instances. It should be noted that variations in specific patient characteristics (duration of complaints, degree of physical pain) can have an impact on whether a treatment is indeed appropriate[18]. In addition to these treatment options, there is a wide range of uncertain treatment modes. Finally, some treatments are, again, generally considered inappropriate except for specific circumstances. However, it is unclear how inappropriate care affects chronic WAD. We did not find sufficient evidence that people receiving inappropriate care are more prone to chronic WAD.

Given the many uncertain medical treatment options, medical care is only a piece of the puzzle to solving chronic WAD. From the non-medical panel, it is clear that treatment and management strategies can assist in preventing a whiplash case from becoming chronic.

[18] See Table 7 providing an overview of (in)appropriate treatment by pain severity and duration of complaints.

4. OVERALL CONCLUSION

With respect to appropriate care, there is still extensive research to be done in combination with diagnostic studies. While it is becoming clearer what is not appropriate, there is still considerable uncertainty about the use (when and for what specific patients) of potential appropriate treatments.

The overall interpretation of the appropriateness panels would be to treat specific symptoms in the acute phase, try to apply a wide series of treatments in the semi-acute phase, and attempt to treat person-related characteristics in the chronic phase which could vary from pain management to psychosocial treatment to non-medical interventions as labor or social training.

At the same time, there are clear indications that there is room for improvement regarding the actual care that is given and (financially) supported. Looking at collars and muscle relaxant are two broadly applied examples of inappropriate care that is still widely provided. We were not able to distinguish among specific patients and the specific care provided, but we suspect that there is potential for improvement in a substantial number of cases for specific instances. Better implementation of the currently available knowledge will improve treatment and reduce costs. Examples of better implementation are the development of stages, long-term treatment plans, early attention to patients that may forestall later costs, and the reduction of costs by reducing the incidence of inappropriate treatment.

ANNEX A: NAÏVE BAYES CLASSIFIER "RISK PROFILES"

Table 12: Weights of evidence

Variable	SE	t-value	Weights of evidence				
Prior	86	-2.32	-199				
			No	Yes			
Male	6.46	-0.14	5	-6			
German	2.71	-0.59	-28	9			
Male and German	36.86	0.05	-3	2			
Citizen	93.66	-0.25	28	15			
Accident insurance	0.38	2.29	119	-36			
Liability	0.27	1.98	-34	82			
Judicial rep	0.43	-0.42	-20	11			
Lawyer	0.41	2.77	-64	174			
			Full time	Part time	Housewife	Other	
Employment	0.38	0.51	-2	-13	24	27	
			<25	25-35	35-45	45-55	>55
Age group	0.67	0.66	-25	-8	7	7	28
			Single	Married	Separated	Divorced	Widow
Marital status	0.75	-0.24	9	-5	-2	-1	-25
			Driver	Front	Back		
Location in car	1.11	1.15	-16	39	63		
Symptoms							
			Absent	Present			
Neck	6.52	-0.64	-31	9			
Head	1.53	0.33	-10	7			
Shoulder	2.58	0.61	9	-20			
Back	0.53	0.85	-9	37			
Arm	1.35	0.13	-2	6			
Leg	0.5	0.45	-2	41			
Tingle	0.81	0.41	-5	22			
Other	1.1	-0.11	1	-6			
Limited	1.78	1.15	38	-21			
Nausea	17.71	0.87	0	-55			
Vomit	8.68	0.65	1	-52			
Dizzy	1.04	0.16	-3	6			
Hear	0.62	1.47	-7	157			
Ringing	0.56	0.01	0	1			
Visual	0.47	-0.08	1	-5			
Attention	0.41	1.05	-10	61			
Fatigue	0.55	0.19	-2	11			
Irritability	0.75	-1.19	7	-113			
Affection	2.57	-2.17	12	-332			
Depression	0.73	0.28	-3	16			
Personality	0.89	-0.05	0	-7			

Table 12 shows the weights of evidence computed from a naïve Bayes classifier fit to the whiplash dataset. They basically represent

$$w_j(x) = \log \frac{P(X_j = x \mid Y = 1)}{P(X_j = x \mid Y = 0)}.$$

That is, if input variable X_j takes on the value x, then the total weight of evidence in favor of the subject developing chronic whiplash increases by $w_j(x)$. The estimated values shown in Table 12 are shrunken using a logistic regression technique as in Spiegelhalter & Knill-Jones (1984). The procedure basically computes estimates for the $w_j(x)$ directly from the data by estimating the probabilities in the numerator and denominator for each variable. Then we create a new data matrix replacing the actual values for the inputs with their weights of evidence, inserting 0 for any missing data elements. Lastly, we use logistic regression to estimate shrinkage coefficients, their standard errors, and a t-statistic for each input variable. These standard errors and t-statistics are shown in the first two columns of Table 12. The Table 12 weights of evidence are the raw weights of evidence multiplied by the shrinkage coefficients from the logistic regression.