Article

A Model of Triage of Serious Spinal Pathologies and Therapeutic Options Based on a Delphi Study

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Abstract: *Background and Objectives*: The relevance of red flags in serious spinal pathology (SSP) evolved throughout the last years. Recently, new considerations have been proposed to expand the consideration of red flags. The purpose of this study was to determine, approve and test a model for the triage and management process of SSP based on the latest data available in the literature. *Materials and Methods*: The SSP model was initially built on the basis of a literature review. The model was further determined and approved by an expert panel using a Delphi process. Finally, clinical scenario were used to test the applicability of the model. *Results*: After three rounds of Delphi process, panellists reached a consensus on a final version of the model. The use of clinical scenarios by experts bring about reflexive elements both on the determined model and on the evocative SSP of the clinical cases. *Conclusions*: The validation of the model and its implementation in the clinical field could help assess the skills of first-line practitioners managing spinal painful patients. To this end, the development of additional clinical scenarios fitting with the determined model should be further considered.

1. Introduction

In several countries, patients can access physiotherapy care without being referred by a physician [1,2]. In some other countries, patients are referred to physiotherapist by family physicians. In these countries, new models of care integrating more autonomous role of physiotherapist are being gradually implemented. For instance, new models of task sharing and shifting are being implemented in France between general practitioners and physiotherapists for patients with non-urgent musculoskeletal disorders such as ankle sprain or low back pain [3]. Its implementation is a major shift for the evolution of physiotherapists' skills, roles and responsibilities, since French patients are traditionally referred to physiotherapists by physicians.

Within the framework of the above-mentioned model of care, an interprofessional training is planned in order to consolidate the knowledge of physiotherapists on triage and prescribing medication and sick leave certificate. This is the first step towards the extension of French physiotherapists' roles and responsibilities. The development of this model emphasizes the need for French physiotherapists to acquire adequate skills to manage patients as first-contact primary care practitioners. Development of self-confidence feeling in their ability to conduct clinical reasoning, triage and differential diagnosis process is required. The early identification of serious spinal pathologies (SPP) among patients with low back pain should especially be part of their clinical practice as first contact practitioners.

Four SPP have been identified by authors [4,5]: fracture, cancer, infection and cauda equina syndrome (CES). Some authors also included axial spondyloarthritis [6,7]. All these SSP are relatively rare as their prevalence does not exceed 1% percent in primary care [8]. Nevertheless, these pathologies can have a serious impact on patient health status and lead to significant costs [9]. Thus,

systematic screening for the early identification of SSP signs and symptoms should be performed by first contact practitioners.

The SSP triage would potentially allow a decrease in the loss of chance for the patients with an earlier identification of serious pathologies. The evolution of the physiotherapists' skills to manage patients as primary care practitioners could lead to a decrease of general practitioners' workload [10]. It could also reduce the emergency department use [11]. However, this evolution have to be implemented with caution to ensure patient safety. Physiotherapists should have the necessary skills for both triage and subsequent management of patients with low back pain.

To help clinicians in the triage of SSP, several guidelines supported the use of the red flags concept [12–14]. Red flags are signs and symptoms that potentially help in the detection of the so-called serious pathologies [4]. However, red flags in these guidelines suffered from a lack of standardization and poor diagnostic capacity [14]. Among the large variety of red flags described in the literature, only few of them seemed to be relevant [13–15]. The red flags did not enable the clinicians to exclude or identify SSP, based on positive and negative likelihood [15]. Furthermore, given the prevalence of these conditions and the clinimetry of red flags, the post-test probability of having a serious spinal condition was relatively low [17]. Several authors called for abandoning discussions because there is currently no consensus on the definition of red flags [16]. Other authors suggested to find a standard definition [15]. Finally, low quality study methodologies do not enable to set up a high evidence level about the red flag use. Larger sample size in primary care settings is needed [17,18]. The association in cluster of several red flags in order to increase their diagnostic capacities investigated may also be an encouraging future research area [15,17,18]. Studies should be conducted with stronger quality and larger sample size. The development of a model for triage of spinal painful patients based on highest evidences and experts opinions could help primary contact practitioners to acquire adequate skills in the assessment and management of these patients.

Thus, the purpose of this study was to determine and approve a model for the triage and management process of SSP based on the latest data available in the literature. The secondary objective was to test the applicability of the determined model through the use of clinical scenarios.

2. Materials and Methods

A Delphi study was conducted, based on available and relevant evidences regarding the triage of patients with serious spinal pathologies. Two steps were undertaken, the first one aimed to synthetize the available literature on the topic through a literature review and the second one consisted in the Delphi process development.

2.1. Step 1 : Literature review and model constitution

A literature review about red and yellow flags was conducted in order to gather the latest data available on the literature on this subject. The research was conducted in the following 4 databases: Medline, Cochrane library, Embase and Google scholar over 2015 until march 2021. The model has been constituted following a systematic bibliographic research. These search terms were extended with specific terminology and synonyms using Boolean operators and the respective Medical Subject Headings is reported in Appendix A. Some specifics filters or limits were used, for example only English articles were included. The selected studies were then used to create a theorical model that included triage and therapeutic options to manage patients with low back pain. The model evaluated in this study was created using diagram.net can be found in Appendix B, C and D for each round. The created model was then exposed and modified through a Delphi process.

2.2. Step 2: Delphi process

This section reporting considers recent recommendations about Delphi process [19–21]. A Delphi methodology have been conducted, considering a relatively weak and non-consensual literature on the subject of red flags use and triage of spinal painful patients. Following current literature, the 'panellist' term was preferred to 'experts' [22,23].

2.2.1. Inclusion criteria of the participants

The following inclusion criteria were used for the selection of panellists participants:

- A minimum of 5 years post-graduation in medicine (general practitioner, rheumatologist, emergency physician) or physiotherapy;
- Clinical practice including a strong musculoskeletal focus (especially on low back pain) associated with knowledge on the issues addressed by the model (triage, management of low back pain);
- Or research activity/publications related to triage and management of musculoskeletal disorders;
- Fluency in French language and reading (since the model was designed in French).

2.2.2. Consensus definition

We used single choice questions for the majority of the questions, from 1 (insufficient) to 7 (sufficient) point Likert scale response options (ordinal variable) [21]. We have chosen to start with a central tendency within a specific range (unrestricted) for more readability [19]. We have taken the medians rather than the averages to avoid the influence of extreme values, especially considering the number of panellists included. An item or group of items were considered to be suitable if the median was greater than or equal to 5/7. An item or group of items obtaining a median between more than 3/7 and less than 5/7 were considered as subject to discussion. For a median of less than 3/7, the item or set of items were considered not validated. The assignment of a score was mandatory. In addition, the participants were also asked to comment any of their scores (for the first round). For the second and third rounds, the participants were asked to comment and suggest when the scores were below 5/7. In the first round, the comments were used as a reference to find a common direction for the model. For the second, if questions were specified in the comments, the participants were independently contacted to answer them. Three rounds for this modified-Delphi model was set a priori, considered as stopping point if consensus not reached before.

2.2.3. Contenu du questionnaire à l'attention des panellists

The *LimeSurvey (GmbH Hamburg, Germany)* platform was used to administer the survey. This platform was secured with an encryption of data. Information about the objectives of the study, the construction of the model, the duration of the questionnaire (average duration of 25 min), the time allowed for its completion (3-4 weeks delay) and the scoring system were first provided to participants. The questionnaire was anonymous. Each participant received a personalized email that contained a link to the questionnaire, the model (modified for the rounds 2 and 3), the bibliography that was used (updated between the rounds), an explanatory summary (for rounds 2 and 3) and a mindmap (for rounds 2 and 3). The mindmap provided a graphic representation of the participants' results (medians and interquartiles were indicated for each answer). The questionnaire contained four groups of questions based on the relevance (interest and localization of the items/groupings of items of the model, the formulation of the items/groupings of items of the model, the clinical reasoning through this model, the model's global approvement (qualitative data) and information about the participants.

The question on the assessment of clinical reasoning through the model was: Does the clinical reasoning, associated with reading the algorithm, seem relevant to you? The question about the model's global approvement was for round 1: Does the algorithm cover all possible scenarios concerning the triage of serious spinal pathologies and the management of low back pain? For round 2: In your opinion, is the proposed synthesis satisfactory to consider the triage and management of spinal pathologies?

2.3. Step 3: Model applicability through clinical scenario

In the third and final rounds, the panellists were asked to approve the latest version of the model. The panelists who approved the model were asked to test it through five clinical scenarios which are

presented in Appendix E. The participants' level of concern, degree of confidence regarding the diagnosis and the clinical evidence for the diagnosis were asked using the approved model. The first clinical scenario related to a suspicion of fracture. The second clinical scenario related to a probable presence of an ankylosing spondylitis. The third one applied to the probable presence of a cancer. The four one applied to the probable presence of a cauda equina syndrome. The five one clinical scenario related to low back pain without any serious pathology. The goal of this last scenario was to explore if the panellists would have taken into account the nervous system examination (see the change in the last question). The main objectives of these clinical cases were:

- To explore the applicability of the model in clinical practice through the clinical reasoning process of panellist,
- To build clinical scenarios for research and educational purposes.

3. Results

3.1. Literature review

After articles selection, 27 studies were included based on full text selection. The whole bibliography used to create the model is available in the references [4–18]. The studies were used to create the triage model which have to be approved by the panellists in the following section. The initial version of the created model is available in Appendix B.

3.2. Delphi study

3.1.1. First round

The sample targeted a panel of 11 panellists. The panel was composed of 5 physicians and 6 physiotherapists in order include varied range of practitioners who primarily manage patients with spinal pathologies [21–23]. Among the physicians, general practitioners, emergency physicians, physical rehabilitation physicians and rheumatologists were represented. French-speaking physiotherapists were recruited in different countries: Canada, Belgium, Switzerland and France are reported in Table 1.

Table 1. Characteristics of targeted panelists.

Panelists	Location	Profession and care access	Included
Panelist 1	France	No primary contact physiotherapist	Yes
Panelist 2	Canada	Primary-contact physiotherapist	Yes
Panelist 3	Switzerland	No primary contact physiotherapist	Yes
Panelist 4	Belgium	No primary contact physiotherapist	Yes
Panelist 5	France	No primary contact physiotherapist	Yes
Panelist 6	France	Family physician with primary contact	Yes
Panelist 7	Canada	Primary-contact physiotherapist	No
Panelist 8	France	Rheumatologist with primary contact	No
Panelist 9	France	Family physician with primary contact	No

Panelist 10	France	Specialist of physical and rehabilitation medicine with primary contact	No
Panelist 11	France	Emergency physician	No

Out of the eleven panellists initially targeted, nine agreed to participate. At the end of the first round, only six of them fully completed the questionnaire. The panel was composed of five physiotherapists and one general practitioner. On the three panellists who agreed to participate but did not ended the first round, two panellists did not answer the questionnaire of the first round and one panellist partially completed the questionnaire.

Following results regarding *relevance* of the model's items at the end of the first and second round were found:

- Three groupings of elements were validated by the panellists: the notion of trauma, the medical history and the physical examination;
- In this same category, five groupings of elements were subject to discussion according to the panellists: fracture, infection, ankylosing spondylitis, cauda equina syndrome and respondent;
- Five groupings of elements were not approved by the panellists: history, cancer, flags (yellow, blue and black), treatment and additional investigations.

Following results regarding *formulation* of the model's items at the end of the first and second round were found:

- 7 elements groupings were validated by the panellists: the notion of trauma, physical examination, fracture, cancer, cauda equina syndrome and treatment;
- 6 groupings of elements were subject to discussion according to the panellists: the history, infection, ankylosing sponditilitis, flags, additional investigations and favorable patient evolution;
- Finally, only 1 grouping of elements was not validated by the panellists: ankylosing spondylitis. Results regarding relevance and formulation of the model's items are presented in Table 2.

Table 2. Relevance, formulation of items in the model in round 1 and 2

	Round 1		Round 2
Items/Category	Relevance	Formulation	Relevance and Formulation
Trauma	(5.5, 4.5)[V]	(5, 3.25)[V]	(6, 2)[V]
History	(2.5, 1.75)[NV]	(3.5, 4.5)[D]	-
Anamnesis	(5.5, 3.5)[V]	(6, 1.75)[V]	-
Physical examination	(6, 2)[V]	(6.5, 1.75)[V]	-
Fracture	(4.5, 2.5)[D]	(5.5, 2.5)[V]	(5.5, 1.5)[V]
Cancer	(2.5, 4)[NV]	(6, 4)[V]	(4.5, 2.5)[D]
Infection	(4, 2.25)[D]	(3.5, 3.5)[D]	(4.3, 3.25)[D]
Ankylosing spondylitis	(3.5, 1.5)[D]	(2.5, 4.25)[NV]	(6,1.75)[V]
Cauda equina syndrome	(4, 2.75)[D]	(5.5, 4.25)[V]	(5.5, 2)[V]
Yellow, blue and black flags	(2.5, 5.25)[NV]	(4.5, 4.25)[D]	(5, 4)[V]
Treatment	(2, 2)[NV]	(5, 4.5)[V]	-
Additional investigations	(2, 2)[NV]	(4.5, 4.5)[D]	-
Favorable patient evolution	(3, 2)[D]	(4, 5)[D]	-
Level of preoccupation and decision	-	-	(5, 2.25)[V]

(Median, interquartile); [V]: item validated ; [D] : item subject to discussion ; [NV] : item not validated.

The item "evaluation of the clinical reasoning in the model" is presented in Table 3 item needed to be further discussed. For the model global approval, three authors reported that there were no obvious missing elements in the model. Two authors stated that the model did not enable the specification of an urgency rating and therefore had a mixed opinion. The last one mentioned that this model did not consider any suspicion of myelopathy, vascular and/or other organic pathologies. Several authors have expressed a desire to see elements of the international framework for red flags [4].

Table 3. Evaluation of the clinical reasoning in the model

	Round 1	Round 2
Items/Category	Evaluation	
Clinical reasoning	(3.5, 2.75)[D]	(4, 3.25)[D]

(Median, interquartile) ; [D] : item subject to discussion

3.1.2. Second round

The model used for this second round is available in the Figure C. Regarding the relevance and formulation of this model reported in Table 2, 6 groupings of elements were validated by the panellists: the notion of trauma, fracture, ankylosing spondylitis, cauda equina syndrome and level of preoccupation and decision. In this same category. Two other groupings of elements were subject to discussion according to the panellists: cancer and infection. The clinical reasoning item presented in Table 3 needed to be further discussed. For the model global approval, four panellists answered that this model could still be improved. The last two panellists were satisfied with this model.

3.1.3. Third round

Following the results of the second round, a new version of the model was designed. This last version of the model is available in Figure D. Five panellists out of 6 finally approved the last version of the model. The panellists were invited to test it through 5 clinical scenarios (see method section). Model testing with clinical scenario are presented in Table 4:

- About the clinical scenario number 1, the panellists agreed to assign a high level of concern. The clinical elements that were most important for this scenario according to the panellists were: the age of the patients, the context of fall/trauma, being menopausal, being a smoker, being a female. The most frequent suggested diagnosis was fracture. Four panellists considered that the clinical elements were not sufficient. The ultimate panellist considered that he had sufficient clinical elements about this clinical scenario can be found in Figure F.
- About the clinical scenario number 2, three panellists assigned a high level of concern. Two others respectively assigned no level of concern and moderate level of concern. The clinical elements that were most important for SpA according to the panellists were: the age of the patient, night pain, the efficacy of non-steroidal anti-inflammatory drugs, the presence of enthesitis. The most probable suggested diagnoses were SpA, chronic non-specific low back pain and non-specific mechanical low back pain. As for the clinical elements presented in the clinical scenario, four panellists considered that they had sufficient clinical elements about this clinical scenario (including two panellists attributed the diagnosis to SpA and two panellists attributing the other two diagnoses). One of the panellists who made the diagnosis of SpA felt that he did not have enough clinical evidence.
- About the clinical scenario number 3, three panellists assigned a high level of concern. The other two respectively assigned a moderate level of concern. The clinical elements that were most important for identifying cancer according to the panellists were: history of cancer, night pain, worsening of pain, thoracic irradiation. The most probable suggested diagnoses were cancer, non-specific low back pain. As for the clinical elements presented in the clinical scenario, four panellists considered that they had not sufficient clinical elements (all of them assigned the diagnosis of cancer). The panellist who specified he had enough clinical evidence (assigned the diagnosis of non-specific low back pain).

- About the clinical scenario number 4, three panellists assigned a high level of concern. The other two assigned a moderate level of concern respectively. The clinical elements that were most important for CES according to the panellists were: weird sensation when the patient urinates, episodes of numbness and tingling and presence of neurological disorders in both legs. The most probable suggested diagnoses were CES, mechanic low back pain. As for the clinical elements presented in the clinical scenario, four panellists considered that they had not sufficient clinical elements about this clinical scenario. The panellist who specified he had enough clinical evidence (assigned the diagnosis of CES).
- About the clinical scenario number 5, three panellists assigned a moderate level of concern. The other two panellists assigned no level of concern. The clinical elements that were most important for this scenario according to the panellists were: no red flags, many blue and yellow flags, sedentary, stressed, divorced and presence of tingling and pins and needles. The most probable suggested diagnoses were NSLBP and NSLBP with radicular symptoms. As for the clinical elements presented in the clinical scenario, three panellists considered that they had not sufficient clinical elements about this clinical scenario. The other two panellists indicated that they had sufficient clinical evidence.

Table 4. Evaluation of the clinical reasoning in the model.

	Clinical scenario n°1	Clinical scenario n°2	Clinical scenario n°3	Clinical scenario n°4	Clinical scenario n°5
Level of concern	High (5/5)*	High (3/5) No level of concern (2/5)	High (3/5) Moderate (2/5)	High (3/5) Moderate (2/5)	Moderate (3/5) No level of concern (2/5)
Important clinical findings	Age (4/5) A context of fall/trauma (5/5) Being menopausal (5/5) Being a smoker and a female (3/5)	Age (2/5) Night pain (3/5), The efficacy of NSAI drugs (2/5) The presence of enthesitis (2/5)	History of cancer (5/5) Night pain Worsening of pain, Thoracic irradiation (3/5)	Weird sensation when the patient urinates (5/5) Episodes of numbness and tingling (4/5) and presence of neurological disorders in both legs (3/5)	No red flags, many blue and yellow flags (3/5) Sedentary, stressed, divorced and presence of tingling and pins and needles (2/5)
Most probable diagnoses and percentages of certainty	Fracture (5/5): 40%-90%	AS (3/5), 50-85% CNSLBP (1/5): 70%, MLBP (1/5): 100%	Cancer (4/5): 50-70% NSLBP (1/5): 40%	CES (4/5): 30-70% MLBP (1/5): 50%	NSLBP: 66-80% (4/5) NSLBP with radicular symptoms: 100% (1/5)
Panellist statement**	Did not have enough clinical elements (4/5) Had sufficient clinical elements (1/5)	Had sufficient clinical elements (4/5) Did not have enough clinical evidence (1/5)	Did not have enough clinical elements (4/5) Had sufficient clinical elements (1/5 NSLBP proposed)	Did not have enough clinical elements (4/5) Had sufficient clinical elements (1/5)	Did not have enough clinical elements (3/5) Had sufficient clinical elements (2/5)

Hx: history, AS: ankylosing spondyloarthritis, NSAIs: non-steroidal anti-inflammatories, CNSLBP: chronic nonspecific low back pain, NSLBP: nonspecific low back pain, MLBP: mechanical low back pain, CES: cauda equina syndrome ; n/5 number of panellists in agreement ; *2 panellists proposed AS diagnosis and 2 panellists proposed CNSLBP and MLB ; ** see appendix E for more details.

4. Discussion

4.1. Overall Results

4.1.1. Findings

This study aimed at developing and testing a model for the triage and management process of SSP. To our knowledge, such a model has not yet been developed. Regarding the final model resulting from the three rounds of the Delphi process, some elements seem to be in line with the Finucane et al framework [4]. At first, one of the main findings is the use of the "level of concern" notion in the clinical reasoning process mapped out by the model. Some items of the model were consistent with others studies on this topic [5–7,12–14,17,18,24–27]. Then, using clinical scenario enable the understanding of the panellists reasoning heuristic of SSP triage. Concerning the last version of model, disagreements were found between panellists regarding the use of yellow, blue and black flags into the model. One panellist invalidated the model at the third round explaining that flags cannot be taken into consideration for a screening. Two panellists expressed the lack of relevance of the use of yellow, blue and black flags, while the rest of the panel underlines its importance. It seems important to point out that during his consultations, a physiotherapist collects many information from his patients, which, in return, will dynamically influence his level of concern. Regarding a zero level of concern, it is appropriate to consider the other flags categories [28]. This would result in the integration of biological factors first and then the consideration of psychosocial factors. It could lead to segmenting the biopsychosocial model (mBPS); whereas the biopsychosocial model is a whole and not segmented model [29–31]. Taking into account red flags alone is insufficient since other factors such as symptom progression, comorbidities, prevalence of pathology, etc. must be considered (see Appendix D). However, knowing which red flags are found in the SSPs remains unavoidable.

Regarding the use of the five clinical scenarios, only the first one obtained the same level of concern according to the panellists. Four scenarios were subject to heterogeneous responses from the panellists. That can be explained because of the difficulty to create indicative clinical scenario for SSP. It appears that most panellists have suspected a SSP, when clinical scenario were built in this way. From the last clinical scenario, it appears that understanding and carrying out of an exhaustive neurological examination should be more questioned. This crucial point should be considered when managing SSP and other pathologies (narrow lumbar canal, neuralgia, neuropathy, neuropathic pain). Many papers encouraged clinicians to perform acute neurological examinations, using as an example the development of clinical sensory test [33–37].

4.1.2. Delphi and clinical scenarios process

Throughout the Delphi process, we noted a discrepancy between the information sent to the panellists to answer their comments and the answers proposed in the next round. In order to limit this discrepancy as much as possible, individual discussions by e-mail were conducted with the panellists to clarify certain answers. The issue of panellists involvement is a relatively common topic in the papers related to the consensus method [19–21]. It seems therefore appropriate to emphasize the strategy developed here in order to remain fully involved in a consensus search and plurality of opinions. Throughout these different rounds, it appears that we have been able to manage and respect the opinions of each panellist to reach the current model. The model varied significantly between the first and the second round. This can be explained because of the difficulties met by the panellists with answer modalities and therapeutic options can be found in Appendix B. The panellists suggested to use the theorical international framework for potential SSP red flags [4]. This significant change enables the consideration of a wider range of answers and therapeutic options. Moreover, in the model of round 2 the mention of medical history, anamnesis, physical examination to facilitate the reading of the model no longer appeared. The complexity of the first model provided a dichotomous tree structure which had to be reconsidered following the feedback from the panellists. Furthermore, in view of the panellists' responses, it was decided to merge the questions on wording and relevance as shown in Table 2. This choice was made in order to avoid repetition, improve data processing and reduce the time needed to complete the survey. We noted that the items for cancer suspicion are quite different between the first and the second model. Indeed, the panellists added several items for the cancer SSP in addition to the type of cancer (< 5 years) and unexplained weight loss. These proposals do not seem to be consistent with the available data [4,5,24,26]. The minor

changes between round 2 and round 3 were reported in Table 3 and Appendix C and D. Following the panellists remark, changes have been made to the "cancer" and "infection" items and some clarifications have been added in the wording. Regarding the clinical cases, despite the involvement of the panellists in the validation of the model, there were divergences on the level of concern, the diagnoses and the percentage of certainty suggested. Only the first clinical case obtained a consensus of the whole panel mentioned in Table 4. The third, fourth and fifth clinical cases obtained a consensus of 4 out of 5 panellists for the SSP initially considered for each case. For the second case, 3 panellists agreed on the SSP initially envisaged in the case. In each of the clinical cases, the panellists wanted more information, in order to increase their suspicion of a SSP reported in Appendix F. The disagreements between the panellists can be explained by the clinical cases themselves. They were intended to be concise and did not include all the elements of each SSP found in the final model.

4.3. Limitations, Strength and Futures directions

The first limit of this study is about the literature review process. We started by analysing the latest existing data on the topic related to the model. One may regret the absence of a systematic approach and extension of the research until 2023. We may have overlooked one or several articles. Nevertheless, considering the feedback from the panellists, no shortcomings have been noted. The end of the third round took place in September 2022. The second limit of the study relates to the panellists who did not include specialized physicians such as a rheumatologist, an emergency physician or a physician in physical medicine and rehabilitation. Even if we expected to include them in the targeted panel of six physiotherapists and five physicians, we did not reach this objective as some panellists that were contacted did not answer our solicitation. Only six panellists agreed to participate, including five physiotherapists and one family physician. That can be explained because of the lack of time of physicians to answer such a study during the COVID crisis. One panellist also reported that the first version of the model was difficult to read. It can be speculated that the complexity of the first model and the length of the first questionnaire may have limited inclusions. We could have extended the recruitment period to include more physicians. However, we made the choice to respect the timeline we had previously defined. The aim was to keep the panellists involved as they were willing to participate in the study. The clinical cases could have benefited from a more exhaustive presentation, by including for example the results of imaging or analysis. In addition, it would have been desirable to know the strategy they could have implemented in each case. Through these clinical cases and the panellists' responses, we were able to capture elements of clinical reasoning and improvements in the suspicion of SSP. The clinical cases proposed to the panellists were not intended to be evocative with a high level of concern, a total consensus and a 100% certainty percentage. This points out that it could be interesting to develop many clinical scenarios and have them tested by physiotherapists in order to further test and develop their clinical reasoning process in SSP specific situations. In addition, it would be interesting to take into account the uncertainty of practitioners in the context of serious spinal pathologies [38,39]. This model provides a global insight on elements to consider for SSP. However, this model does not lessen the complexity nor the uncertainty faced in clinic. Future studies are needed to further assess the reproducibility of our model through rigorous methodology.

5. Conclusions

Overall, the validation of the model and its implementation in the clinical field could help assess the skills of first-line therapists who manage patients with spinal pathologies. However, we do not yet have a weighting of the clinical elements that can define a level of concern. The development of future clinical scenarios evaluating this last point for SSP in collaboration with panellists should be considered. In the future the model could also be used for educational and research purposes. It could be a promising tool to improve triage and management process of patients with low back pain and support need for physiotherapists to acquire adequate skills to manage patients as first-contact primary care practitioner.

Appendix A

	For red flags elements:	
	For PubMed, until March 2021	
	Search equations	
#1	((low back pain[MeSH Terms]) OR (back pain injuries[MeSH Terms])) AND (triage[MeSH Terms])	12
#2	((low back pain[MeSH Terms]) AND (Diagnosis, Differential[MeSH Terms])	15
#3	((((low back pain) AND (diagnosis)) AND (red flag*)) AND (primary health care)) AND (humans)	20
#4	((((low back pain) AND (diagnosis)) AND (red flag*)) AND (humans)	60

	For Scholar, until March 2021	
	Search equations	
#1	low back pain + triage + Primary Health Care + diagnosis, differential + humans + Symptom Assessment + Cauda Equina Syndrome + infection + Fractures + spinal + Pathology + cancer + red flags	74
#2	low back pain + triage + diagnosis, differential + humans + primary health care + Symptom Assessment + Cauda Equina Syndrome + spinal + Pathology + red flags + specific spinal pathologies	90
#3	Low back pain + Primary Health Care + diagnosis, differential + humans + primary health care + Symptom Assessment + Cauda Equina Syndrome + infection + Fractures + spinal + Pathology + cancer + red flags	278

	For Cochrane and Embase, until March 2021	
	Search equations	
#1	[Low Back Pain] explode all trees and with qualifier(s): [diagnosis - DI]	105
#2	Low back pain AND Diagnosis AND Cancer AND Spinal AND Infection AND Humans	78
#3	Low back pain AND Clinical reasoning	65

	For yellow flags elements:	
	For PubMed, until March 2021	
	Search equations	
#1	(low back pain[Mesh] OR low back pain [tiab]) AND (yellow flag* OR psychological risk factor* OR biopsychosocial OR psychosocial) AND (screening OR evaluation OR diagnosis) AND (prognosis OR predictors)	129

#2	(low back pain low [Mesh] or low back pain [tiab]) AND (yellow flag* OR psychological risk factor* OR biopsychosocial)	251

For Scholar, until March 2021		
Search equations		
#1	"low back pain" ("psychological risk factor" OR "yellow flag")	303

For Cochrane and Embase, until March 2021		
Search equations		
#1	(yellow flag AND psychological risk factor OR biopsychosocial) AND low back pain	463

Appendix B

https://osf.io/fzx82/?view_only=6fd7c26d95664fafab6adb224d1fc7ff

Appendix C

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Appendix D

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Appendix E

- Clinical scenario n°1:

A 65-year-old patient sees you for low back pain. According to the patient, this pain appeared three days ago following a nasty fall. She explains that she slipped on a patch of ice while getting to work. She reports that she suddenly fell on her buttocks. In addition, she states that she felt a sharp pain at the moment. However, she could go painfully to the place of her work. Once there, she felt a substantial pain at the top of her right buttock. It was particularly marked while sitting; she stood up regularly on the first day to relieve the ache. The pain at the top of her right buttock is constant and does not give way. The patient was not able to assign a score to her pain. She has not perceived any change for three days. She mentioned that she used a memory foam cushion to try to reduce her pain, but it did not relieve her. In addition, she says she has taken painkillers within the last three days, but they have not had any effect. Since this episode, the patient has had much trouble falling asleep. She sleeps five hours a night (usually, she sleeps about seven hours). According to her, sleeping is impossible if the buttocks are bearing either on the side or the back, so she can only sleep on her stomach. The patient's history refers to celiac disease diagnosed when she was five years old, early menopause at thirty-nine, and a former smoker (stopped five months ago, fifteen cigarettes a day for fifteen years). Last point, the patient reports a bruise at the top of the right buttock.

Although she has easily been bruised, she thinks this bruise did not exist before the fall. No neurological disorder was objectified, and the morphostatic examination did not identify any disorder. The patient is worried because she is afraid of having broken something. She is visiting you because her family doctor cannot see her. In addition, as a chartered accountant, it is a pivotal period with a massive amount of work. Due to this pain, she fell far behind in delivering her calendar year-end reports. From a sporting point of view, she would like to be able to resume her activities, i.e., dance classes twice a week..

- Clinical scenario n°2:

A 27-year-old patient consults you for low back pain that has been present for five days. The patient does not see what could have caused this pain. He is currently in the last year of his thesis in biochemistry, and he spends much time sitting, but he says that he also does a lot of physical activities

such as running and cross-fit (three to five times a week). In addition, he evokes another pain in the left heel that can sometimes hinder him from running. He does not remember how long it bothers him. He manages to maintain his physical activities except during severe episodes. He specifies that he has often had periods of low back pain since he was 20 years old. He associates these periods either with his sitting posture or stress due to professional constraints or sporting overactivity. In addition, he noticed that his sleep was often impaired during painful episodes and that he had some trouble going back to sleep once awake. The patient has a history of a sprain in the right ankle in 2017, a fracture of the right shoulder following a fall from a scooter in 2012, and psoriasis diagnosed in 2020. Referring to this painful episode, the patient has no notion of trauma. The physical examination did not objectify any neurological disorder; no disorders were identified at the cutaneous and morphostatic levels. The patient has turned to you because he would eventually like to understand what is happening to him. He mentions that in painful episodes, he was prescribed nonsteroidal anti-inflammatory drugs (NSAIDs), which relieved him but also resulted in stomach pain. He would like to stop taking NSAIDs.

- Clinical scenario n°3:

A 27-year-old patient consults you for low back pain that has been present for five days. The patient does not see what could have caused this pain. He is currently in the last year of his thesis in biochemistry, and he spends much time sitting, but he says that he also does a lot of physical activities such as running and cross-fit (three to five times a week). In addition, he evokes another pain in the left heel that can sometimes hinder him from running. He does not remember how long it bothers him. He manages to maintain his physical activities except during severe episodes. He specifies that he has often had periods of low back pain since he was 20 years old. He associates these periods either with his sitting posture or stress due to professional constraints or sporting overactivity. In addition, he noticed that his sleep was often impaired during painful episodes and that he had some trouble going back to sleep once awake. The patient has a history of a sprain in the right ankle in 2017, a fracture of the right shoulder following a fall from a scooter in 2012, and psoriasis diagnosed in 2020. Referring to this painful episode, the patient has no notion of trauma. The physical examination did not objectify any neurological disorder; no disorders were identified at the cutaneous and morphostatic levels. The patient has turned to you because he would eventually like to understand what is happening to him. He mentions that in painful episodes, he was prescribed nonsteroidal anti-inflammatory drugs (NSAIDs), which relieved him but also resulted in stomach pain. He would like to stop taking NSAIDs.

- Clinical scenario n°4:

A 40-year-old patient comes to see you following pain in the lower back. These appeared two days ago on their way home from a jog. There is no context of any trauma. The patient specifies that he initially had pain in the left leg, and since this morning, he has had pain in both legs. He thinks they are muscular aches but more intense than usual. The patient's situation is as follows: The patient's situation is as follows: he is single and works as a teacher in a management school. The patient is a regular runner and evokes that he is in preparation for a future half marathon, which takes place in 2 months. In addition, he sleeps less than usual; he mentions that he sleeps 5 hours instead of 7 hours. For one week, the patient has had stomach aches and episodes of numbness and tingling in the thighs; then, he reports feeling weird when he urinates. He has some difficulty describing the last symptom. No neurological disorder is objectified at the physical examination, and there is nothing to report at the cutaneous and morphostatic levels. The patient's history referred to tendinopathy of the right Achilles tendon four years ago and a sprain on the right ankle two years ago. The patient wants to know if this pain will go away independently or if he should start any special treatment.

- Clinical scenario n°5:

A 44-year-old patient comes to see you for back pain that appeared six days ago. He woke up one morning with a bar on his back. That helm feeling is always present and disabled him in his daily activities. In a sitting position, he reminds you that he has the sensation of having paraesthesia/tingling in his left leg. The patient is a trader, currently in divorce proceedings with his ex-wife. In addition, it spends about 10 to 12 hours sitting with little break due to professional

activities. He does not practice any physical activity because he does not have time because of his calendar. Since the onset of symptoms, he tolerates very poorly the sitting position. He succeeds in decreasing symptoms by walking more than 15 minutes, but the pain quickly comes back, accompanied by a slight improvement in tingling/tingling. He also struggles with everyday tasks, such as donning pants and socks. If he acts too suddenly, it triggers severe pain in the back. The patient talks with you about his medical history: type 1 diabetes and rupture of the right anterior. The patient would like the situation to improve as soon as possible because it prevents him from fully dedicating himself to his work. Moreover, the patient mentions that the atmosphere at his work is not so good since the results of different traders are not as good as a result of various bad choices in recent investments. He is willing to participate in treatment actively but wants it to remain feasible in view of his situation.

Appendix F

	Clinical scenario n°1	Clinical scenario n°2	Clinical scenario n°3	Clinical scenario n°4	Clinical scenario n°5
Panellists statement**	Did not have enough clinical elements (4/5) more information about Hx of fracture, have additional examinations Had sufficient clinical elements (1/5)	Had sufficient clinical elements (4/5) more information about Hx of AS and morning stiffness (5/5) Did not have enough clinical evidence, this panellist expected blood tests, Hx of As and complementary tests (1/5)	Did not have enough clinical elements (4/5) more information about weight loss, gait disturbance, thorough exploration of nocturnal pain and request for further examination Had sufficient clinical elements (1/5 NSLBP proposed)	Did not have enough clinical elements (4/5) more information about different sensations when urinating or defecating, alteration of sexual intercourse and one talk about performing a nervous system examination More information on lower extremity symptoms to distinguish radicular pain versus referred visceral pain (1/5 MLBP proposed) Had sufficient clinical elements (1/5) specified his wish to carry out a thorough neurological examination with MRI, EMG	Did not have enough clinical elements (3/5) would like to perform a complete clinical examination, neurological examination to detect possible disorders Had sufficient clinical elements (2/5)

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