



ORIGINAL ARTICLE

Evaluation of ChatGPT Responses to Questions About Joint Health and Physiotherapy in Patients with Hemophilia

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Abstract

Introduction: This study aimed to evaluate whether ChatGPT provides satisfactory responses to frequently asked questions (FAQs) about joint health and physiotherapy approaches for patients with hemophilia.

Methods: Fifty questions were reviewed by five expert physiotherapists, who selected the 10 FAQs. Responses were generated using the GPT-4o model of ChatGPT on March 27, 2026. Two non-blinded reviewers independently evaluated the responses using a predefined four-point rating system based on accuracy, completeness, clarity, and clinical relevance. Inter-rater reliability was assessed using the intraclass correlation coefficient (ICC) with a two-way random-effects model for absolute agreement. All responses were analyzed using the Flesch–Kincaid readability index to assess readability.

Results: The median response accuracy score (RAS) was 2, indicating that responses were generally satisfactory and required minimal clarification. Inter-rater reliability between the two reviewers was good (ICC=0.847). The Flesch–Kincaid score was 25, indicating that ChatGPT responses were difficult to read and understand by college graduates.

Discussion and Conclusion: ChatGPT demonstrated potential to improve basic knowledge of joint health in hemophilia, with excellent responses to 30% of FAQs. However, responses to physiotherapy-related questions often required additional clarification, particularly regarding exercise prescription parameters. Because physiotherapy interventions are individually tailored and require clinical supervision, ChatGPT may enhance patients' knowledge but cannot replace supervised physiotherapy practice. Therefore, ChatGPT should be considered a complementary tool rather than a primary clinical decision-making resource. Integrating artificial intelligence with physiotherapy expertise may enhance patient education and hemophilia care.

Keywords: Artificial intelligence; ChatGPT; Hemophilia; Joint health; Patient education; Physiotherapy

The use of artificial intelligence (AI) tools has become quite widespread in musculoskeletal rehabilitation, including physiotherapy.^[1] Chat Generator Pre-Trained Transformer (ChatGPT) is a freely accessible program that attempts to provide responses to a wide range of questions from reinforcement learning using human feedback. ChatGPT

gained significant popularity, reaching over a billion monthly users within 4 months after its introduction in 2022. This widespread adoption of ChatGPT has significantly increased research publications investigating its potential utility in both academic and clinical settings. Continuous improvement in the AI tools over time is important for

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Table 1. ChatGPT response rating system^[9]

Accuracy description	Response accuracy score
1-Excellent response not requiring classification (The response was extremely accurate and comprehensive, providing information without the need for much explanation.)	1
2-Satisfactory requiring minimal clarification (The response was evaluated accurate; however, it required minimal additional clarification to address the user's question.)	2
3-Satisfactory requiring moderate clarification (The response is still accurate, but it is required a moderate level of further clarification to meet the user's needs).	3
4-Unsatisfactory requiring substantial clarification (The answer was deemed to be largely misinformed and overly generalized, which could cause misunderstanding by the user)	4

improving their reliability in physiotherapy practice. The reliability of physiotherapists' clinical reasoning using ChatGPT has also been demonstrated in the literature.^[2] ChatGPT may have difficulties being readable for those below a university reading level.^[3] ChatGPT has high potential for musculoskeletal rehabilitation education and debriefing but needs to be carefully integrated into practice due to its variability in complex clinical reasoning tasks.

Significant advances in pharmacological treatment have increased the life expectancy of patient with hemophilia (PwH) and allowed their active life. Besides pharmacological treatment options, non-pharmacological treatment modalities are critical for maintaining or improving joint health and physical function and for promoting regular physical activity.^[4] Although physiotherapy has adapted to many changes in hemophilia in recent years, comprehensive care cannot be implemented in many physiotherapy centers, and there is great heterogeneity in practices.^[5] With the COVID-19 pandemic, ensuring PwH has equal access to virtual counseling and tele-rehabilitation opportunities is critical to hemophilia care.^[4] This situation can serve to help underserved PwH who have difficulty getting access to a physiotherapist with expertise in hemophilia to maintain and improve joint health.

A study focusing on the potential role of ChatGPT in total hip arthroplasty showed that it provided minimal to moderate explanations of frequently asked questions (FAQs) and could be used for patient education.^[6] Another study reported that ChatGPT provided satisfactory to excellent responses to 60% of questions on ulnar collateral ligament reconstruction.^[7] The use of ChatGPT in hemophilia is almost non-existent in the literature.

Joint health in hemophilia is a major cause of morbidity and continues to be a significant concern for PwH. During their life, PwH find themselves facing a wide variety of information and treatment choices regarding physiotherapy

approaches, manual therapy techniques, exercise type, physical activity recommendation, the duration and frequency of physiotherapy, and appropriate timing after a surgical operation. Using ChatGPT technology may have the possibility to both improve the knowledge of PwH regarding joint health and provide insights for clinical decision-making for physiotherapists who have no specialized expertise in hemophilia. The aim of this study is to determine whether ChatGPT provides satisfactory responses to FAQs about joint health and physiotherapy approaches in hemophilia. We hypothesized that ChatGPT would provide satisfactory responses to basic questions related to joint health and physiotherapy approaches in PwH.

Materials and Methods

Five physiotherapists, who have expertise in hemophilia, were initially provided with 50 clinically relevant questions and instructed to generate a final list of 10 encountered FAQs in clinical practice, specifically related to joint health and physiotherapy (Appendix 1). The evaluators were not blinded to the model or question content during this selection process. Subsequently, and in accordance with a methodology previously described by Artioli et al.,^[8] the resulting 10 FAQs were independently submitted to ChatGPT (GPT-4o), a large language model reported to be optimized for real-time responses. Queries were administered through the publicly accessible online interface on 27 March 2026.

Each response was recorded after the initial query without any follow-up prompts. All questions were presented in a standardized format to ensure consistency across inputs and to enhance the reproducibility of the assessment.

Response quality was assessed using an evidence-based four-point rating system adapted from Mika et al.^[6] The system included four distinct categories (Table 1). Inter-rater reliability between the two reviewers was evaluated

Table 2. Evaluate ChatGPT's response accuracy score

Questions	RAS A1	RAS A2	Overall
Q1: What are the treatment options other than pharmacological treatment for joint health in hemophilia?	2	2	
Q2: What should I do in acute bleeding for joint health in hemophilia?	1	1	
Q3: Which physiotherapy approaches are used to improve joint health in hemophilia and can you prepare a sample treatment weekly plan?	3	2	
Q4: Which manual therapy techniques are used to improve joint health in hemophilia?	3	3	
Q5: What types of exercises are recommended to improve joint health in hemophilia?	2	2	
Q6: If I do not receive physiotherapy treatment for joint health, what changes will occur in my body in the long term?	1	1	
Q7: What are the potential risks of physiotherapy applications in hemophilic individuals?	1	1	
Q8: What should be the duration and frequency of physiotherapy for joint health in hemophilic individuals?	2	2	
Q9: Does fitness or physical activity improve joint health in hemophilia?	3	3	
Q10: What is the success rate of surgery for joint health problems in hemophilia and when should physiotherapy be started?	2	3	
Median accuracy score (interquartile range)	2 (1.5–2.5) 1.42–2.58	2 (1.5–2.5) 1.42–2.58	2 (1–3) 1.63–2.37

RAS: Response accuracy score.

using a two-way random-effects intraclass correlation coefficient (ICC) model with absolute agreement (ICC[2,1]) and reported with 95% confidence intervals (CI). Because RAS was ordinal (1–3 scale), descriptive statistics were summarized using median and interquartile range (IQR). ICC values were interpreted as follows: poor (<0.50), moderate (0.50–0.75), good (0.75–0.90), and excellent (>0.90) reliability.

Readability was assessed using standardized readability formulas to evaluate how easy or difficult the responses generated by ChatGPT were to read and understand. The following indices were used: Flesch–Kincaid, Gunning Fog Index, Simple Measure of Gobbledygook, Automated Readability Index, and Dale–Chall Readability Score. This study did not require institutional review board approval.

Results

Response Accuracy Evaluation and Readability Checker

The list of FAQs asked to ChatGPT and the median response accuracy score (RAS) was 2 (%95 CI: 1.63–2.37), indicating that the answers were satisfactory and required minimal clarification in Table 2. Inter-class consistency (ICC) of ChatGPT responses was measured as (ICC=0.847). Responses to each question were pasted into a readability calculator and assessed using WordCalc software, where

the corresponding responses were recorded in Table 3. Readability scores indicate that the responses can be easily understood by the average college graduate.

ChatGPT Response Analysis

ChatGPT responses to the 10 questions addressing joint health and physiotherapy management in PwH were presented in Appendix 1. Each response was independently evaluated by the reviewers for accuracy, completeness, and clinical adequacy.

Question 1 Analysis: Satisfactory Response Requiring Minimal Clarification

ChatGPT's response to non-pharmacological treatment options for joint health provides a comprehensive overview of the care in hemophilia. However, this answer does not provide information on which treatments to choose when considering the joint health status of PwH's. It also does not include the advantages and disadvantages of these treatment options compared to each other. It also does not provide any guidance on when to consider orthopedic intervention. Biopsychosocial multimodal approaches such as cognitive behavioral therapy, have been proven effective in reducing pain and kinesiophobia while improving quality of life and emotional status in PwH.^[9]

Table 3. Individual readability level of ChatGPT's response

Questions	Flesch-Kincaid	Gunning Fog index	Simple Measure of Gobbledygook index	Automated Readability index	Dale-Chall
Q1	9.47	20.39	16.93	24.42	5.87
Q2	27.46	14.88	13.46	20.96	7.45
Q3	34.34	13.32	11.49	17.29	8.28
Q4	30.02	13.65	12.06	19.83	7.29
Q5	35.23	13.82	12.66	18.78	8.46
Q6	26.32	15.88	14.18	20.26	7.84
Q7	16.06	19.86	17.17	22.88	8.40
Q8	27.53	16.13	14.43	19.80	8.06
Q9	26.78	19.58	16.99	21.75	8.34
Q10	17.30	17.96	15.77	20.97	8.70
Average	25.05	16.54	14.51	20.69	7.86

Question 2 Analysis: Excellent Response Not Requiring Clarification

ChatGPT wisely emphasizes that, just like the hemophilia guidelines, factor replacement should be done rapidly, and then bleeding should be controlled using the RICE principle.^[10,11] The onset of pain, local discomfort, joint fullness, and a tingling sensation are the most common signs that bleeding has begun in the hemophilic individual.^[10] If replacement therapy is not started immediately after the onset of joint bleeding, hemarthrosis will progress rapidly within a few hours, and the associated temporary functional impairment will develop into a painful, hot, and swollen joint. Administration of clotting factors rapidly relieves pain, but inflammation and functional impairment may persist for some time, depending on the amount of blood in the joint. The information given regarding the start of physiotherapy is particularly accurate. Prolonged rest periods may cause muscle weakness and loss of joint control, while early mobilization carries the risk of re-bleeding. Physiotherapy should be started once the acute symptoms of swelling, redness, and loss of movement have subsided.^[12] A gradual strengthening program is also the right approach afterwards.

Question 3 Analysis: Satisfactory Response Requiring Moderate Clarification

The most commonly used methods were physiotherapeutic approaches, such as strengthening exercises, education, range of motion exercises, soft tissue techniques, taping, and manual therapy, while less common methods were massage, electrotherapy, splinting, and ultrasound therapy.^[5] However, the response does not address kinesiotherapy, electrotherapy, ultrasound therapy, and massage. The

recommendation to work closely with a hematologist and physiotherapist specializing in hemophilia care is advised for PwH to assess the factor level in each patient and to select physiotherapy approaches based on the joint health status life-span of life.^[13]

Question 4 Analysis: Satisfactory Response Requiring Moderate Clarification

Manual techniques are given subheadings and in general terms. For example, "How many strokes were made in myofascial techniques, how many deep and superficial techniques were applied?"^[14] "Which technique was used in joint mobilizations?"^[15] "Was a traction pattern applied in joint mobilizations?"^[15] How the movements were made should be stated. The techniques used, the methodology, and their characteristics are not explained in detail.

Question 5 Analysis: Satisfactory Response Requiring Minimal Clarification

In the Chat GPT response, a range of motion, strengthening, proprioception, balance, stretching, functional, and low-impact aerobic exercises were explained in detail with examples. In the systematic review evaluating the effect of exercise on postural balance in hemophilia, it is seen that these exercises are given as an intervention.^[16] However, the questions "How long were these exercises done? Were there any pauses between sets/repetitions? How many series were developed?" were not answered. In the systematic review reporting exercise variables and pain threshold for strength training protocols in PwH, variables such as frequency, duration, intensity of exercise, whether the exercise was supervised, whether any equipment was needed, and exercise progression were evaluated.^[17]

Question 6 Analysis: Excellent Response not Requiring Clarification

The possible conditions and effects that may occur if they do not receive physiotherapy treatment are clearly and accurately stated, just as stated in the hemophilia guidelines. Recurrent joint bleeding in hemophilia may lead to irreversible damage to the musculoskeletal system as a late symptom.^[10] Pain and depression/anxiety correlate with the severity of hemophilia and have negative effects on health-related quality of life.^[18] It has been reported that PwH may be able to preserve joint health with improved treatment strategies. Surgical interventions for hemophilia can be performed at a younger age and may carry a higher risk of complications,^[19] but with physiotherapy treatment strategies, joint health can be improved and surgical procedures can be postponed to older ages.

Question 7 Analysis: Excellent Response Not Requiring Clarification

Physiotherapy must be approached cautiously due to the unique risks involved. Improper or aggressive physiotherapy can lead to complications due to the bleeding tendency inherent in hemophilia. The fact that ChatGPT particularly touched upon the issues of lack of qualified supervision, the importance of biomechanics, and exercise timing as risks of physiotherapy are signs that evaluated the subject holistically. Individualized exercise program, slow and gradual progression, factor replacement before treatment, and multidisciplinary approaches recommendations are very important to reduce risks. It has been shown in the literature that the supervised physiotherapy program was successful in improving joint health, functional capacity, quality of life, risk of fall, and kinesiophobia.^[20]

Question 8 Analysis: Satisfactory Response Requiring Minimal Clarification

ChatBot correctly highlights that the frequency of physiotherapy must be carefully tailored to their specific needs and current condition. It also states that the frequency of physiotherapy will be specifically adjusted in supervised programs, home exercise programs, and periods after bleeding or surgery. However, no response was provided on the duration of physiotherapy sessions and exercise duration. Through interaction with children with hemophilia and their families, the DOLPHIN Exercise program was designed and developed to include weekly stretching, balance, strengthening, and functional activities.^[21]

Question 9 Analysis: Satisfactory Response Requiring Moderate Clarification

ChatGPT explained in a comprehensive overview of the effects of fitness and physical activity on the body of a hemophiliac individual, including precautions. However, the response does not address the use of factor before fitness or physical activity or the minimum factor level. It did not provide sufficient information to avoid high-impact activities such as running and soccer.

In today's age of new treatments, hemophilic individuals need to be encouraged to engage in physical activity. In the study evaluating the types of physical activity of 374 hemophilic individuals, their participation in low-impact activities such as walking, swimming, or cycling was high (90.9%).^[22] Nowadays, PwH's participate in competitive sports with factor therapy. Fitness was found to improve not only joint health but also psychosocial well-being and self-esteem in young men with hemophilia aged 18–25 years, with participants also reporting additional benefits such as less kinesiophobia, reduced pain, weight loss, and improved self-esteem.^[23] Low physical activity levels in PwH may significantly affect the risk and severity of abdominal fat and hypertension and various cardiometabolic and/or musculoskeletal health problems in aging hemophiliacs.^[24] Therefore, regular multimodal training is important for PwH, and the first priority for PwH to participate in this type of program is to be under adequate factor treatment. To provide safety, fitness or physical activity individually adapted to the PwH's needs should be prescribed and supervised by a physiotherapist experienced in the field of hemophilia.^[23] It has been shown that the participation of PwH in physical activity was affected not only by their own abilities and attitudes but also by family, friends, and health professionals.^[25]

Question 10 Analysis: Satisfactory Response Requiring Minimal Clarification

ChatGPT accurately states that the time to start physiotherapy should be as soon as possible but it is specific to the type of surgery, the severity of hemophilia, and the individual's status. However, no information was provided in the response regarding the exercise content in the post-operative physiotherapy phases. The use of clotting factor replacement allows earlier and more intensive rehabilitation in the post-operative period in PwH. Various orthopedic interventions can be applied to PwH for joint health: Arthroscopic synovectomy and joint debridement, radial head resection, tibial

osteotomy, arthrodesis, tendon lengthening, and total joint arthroplasty. In the hemophiliac and factor VIII inhibitor case undergoing total knee replacement, supervised physiotherapy has been shown to benefit from combining 6 weeks of pre-operative physiotherapy with 6 weeks of post-operative rehabilitation to increase the range of motion and muscle strength, facilitate rapid mobilization and recovery of function, and minimize the risk of bleeding.^[26] Although the pre-operative range of motion (ROM) is the most important variable affecting postoperative ROM in total knee arthroplasty, early mobilization should be offered in the 1st post-operative days to improve the outcome. Isometric contractions and gentle open kinetic chain exercises should also be initiated to prevent quadriceps inhibition and restore control. In recent years, structured exercises consisting of closed kinetic chain exercises have been shown to produce improvements in physical activity, balance, proprioception, and gait in PwH's.^[27] As part of comprehensive care, both pre- and post-operative physiotherapy is essential to achieve optimal functional outcome and thus optimal quality of life in PwH.

Discussion

This study evaluated the quality of ChatGPT-generated responses related to joint health and physiotherapy management in PwH. Overall, ChatGPT demonstrated acceptable performance, with 30% of responses rated as excellent, 40% requiring minimal clarification, and 30% requiring moderate clarification. The descriptive comparison across question categories suggests that ChatGPT's responses have a more consistent performance in general educational content, and clinically detailed questions required greater clarification. These findings suggest that ChatGPT may support health literacy and acquisition, particularly among patients with limited access to specialized physiotherapy services, caregivers, and non-specialist clinicians.

ChatGPT demonstrated high accuracy (80%) and strong reliability in aligning its responses with evidence-based information when used as a clinical decision-support tool in physical therapy.^[1] Similarly, satisfactory responses (90%) have been reported for preoperative questions in total hip arthroplasty,^[6] while lower rates (60%) were observed in UCL reconstruction.^[7] McCarthy et al.^[28] reported that ChatGPT-generated accurate responses in cases (88%), although patients perceived professionally developed educational materials as more useful. In patellar tendinopathy, ChatGPT provided comprehensive information but exhibited

limitations in accuracy and readability.^[3] Consistent with these findings, ChatGPT has also been identified as a reliable and accessible source of information for caregivers of PwH, particularly for FAQs, while remaining a complementary resource rather than a substitute for healthcare professionals.^[29] Given the individualized nature of physiotherapy interventions and exercise prescription, clinical decision-making should continue to rely on professional assessment and supervision. Although future advances in artificial intelligence may facilitate more personalized rehabilitation recommendations,^[30] AI-based tools are currently best viewed as educational and decision-support resources that can enhance patient knowledge rather than replace physiotherapy practice.

Although ChatGPT demonstrated relatively high Flesch–Kincaid readability scores and may be useful for patient education, readability alone does not reflect clinical accuracy, safety, or contextual appropriateness. Consequently, AI-generated content should not be used independently by patients, particularly in complex conditions such as hemophilia that require individualized hemophilia care. Instead, ChatGPT should be viewed as an adjunctive educational tool that can assist healthcare professionals in generating patient-friendly explanations, while clinical oversight and content validation remain essential.^[3]

Conclusion

Despite these potential benefits, several important limitations should be acknowledged. Large language models may generate inaccurate or fabricated outputs, which may pose risks in hemophilia, particularly in relation to bleeding management and exercise prescription. Readability metrics, while useful for assessing linguistic accessibility, do not capture clinical validity, safety, or contextual appropriateness. In addition, model updates, prompt sensitivity, and inherent system variability may affect response consistency, thereby limiting reproducibility and cross-study comparability. An additional limitation of this study is the potential for evaluator bias. Although response quality was assessed using predefined criteria and expert review, the evaluation process inevitably involved subjective judgment, which may have influenced the assigned ratings. Furthermore, the rating framework used in this study, although widely applied in the literature, lacks external validation. Therefore, AI-generated outputs should be interpreted cautiously and verified against evidence-based guidelines and clinical expertise before being incorporated into patient care.

Ethics Committee Approval: Ethical approval and informed consent were not obtained as publicly accessible Chat Generator Pre-Trained Transformer (ChatGPT) is a free and openly accessible program were used and no human/animal participants were included in the study. This study did not require institutional review board approval.

Informed Consent: Informed consent were not obtained and human participants were not included in the study.

Conflict of Interest: None declared.

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Use of AI for Writing Assistance: ChatGPT (GPT-4o) has been used.

Authorship Contributions: Concept: NMT; Design: NMT; Supervision: AMT; Data collection and/or processing: NMT, AMT; Analysis and/or interpretation: NMT, AMT; Literature review: NMT, AMT; Writing: NMT; Critical review: AMT.

Peer-review: Double blind peer-reviewed.

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Appendix 1. List of questions and ChatGPT's responses

Question 1: What are the treatment options other than pharmacological treatment for joint health in hemophilia?

ChatGPT Response:

1. Physiotherapy and Exercise: Strengthening muscles, flexibility exercises, balance and coordination training, and low-impact activities such as swimming, cycling, and walking.
2. Orthopedic Interventions: Bracing or splinting, orthotic devices, and surgical options (if joints are severely damaged) like synovectomy, joint replacement, or arthroscopic procedures.
3. Lifestyle Modifications: Weight management and avoiding high-risk activities (e.g., contact sports).
4. Education and Prevention: Teaching proper body mechanics and safe movement strategies. Early recognition of joint bleeds to treat them promptly.
5. Occupational Therapy: Helps patients adapt their daily activities to protect joints and maintain independence.
6. Complementary Therapies (used cautiously): Techniques like Tai Chi or Yoga.

Analysis: Satisfactory Response Requiring Mild Clarification

ChatGPT's response to non-pharmacological treatment options for joint health provides a comprehensive overview of the care in hemophilia. However, this answer does not provide information on which treatments to choose when considering the condition of people with hemophilia, nor does it include the advantages and disadvantages of these treatment options over each other. It did not offer any guidance on when orthopedic intervention would be preferred.

Question 2: What should I do for joint health in acute bleeding in hemophilia and can you create an emergency intervention guide in such a case?

ChatGPT Response: "It's critical to act fast and correctly to protect the joint long-term."

1. Immediate Actions ("R.I.C.E.") (See Table-1. Quick Checklist for Acute Joint Bleed in Hemophilia)
2. Factor Replacement Therapy: Administer clotting factor concentrate as soon as possible – ideally within 2 h. Dose depends on severity and type of hemophilia.
3. Early Phase Rehabilitation (first 24–72 h): Continue "R.I.C.E.". Pain management: Use prescribed medications if needed (avoid NSAIDs like ibuprofen unless advised – they can worsen bleeding). Monitor signs: Watch for increased swelling, redness, or inability to move.
4. Post-Acute Phase (after bleeding is controlled): Gentle Mobilization: Start pain-free range of motion exercises (under physiotherapist supervision). No weight-bearing until cleared. Gradual Strengthening: Progress to light strengthening exercises. Focus first on isometric exercises.
5. Long-Term Joint Protection: Restore full range of motion, strengthen muscles to prevent future bleeds, train for joint stability and proprioception, prevent Re-bleeding: Gradual return to daily activities and sport. Continue low-impact exercise.

Question 3: Which physiotherapy approaches are used to improve joint health in hemophilia?

ChatGPT Response: "Physiotherapy is a core part of joint care in hemophilia."

1. Range of motion (ROM) Exercises: Passive (therapist moves the joint) early if patient cannot move. Active (patient moves the joint) when pain/swelling allows. Example: Gentle bending and straightening of the elbow or knee.
2. Strengthening exercises: Start with isometric exercises. Progress to light resistance exercises once healing advances. Example: Quadriceps setting.
3. Proprioception and balance training: Standing on one leg. Balance boards or foam surfaces. Progress slowly to avoid micro-bleeds.
4. Functional training: Gait training. Step-ups, sit-to-stand exercises.
5. Manual therapy (when stable): Gentle joint mobilizations (only by trained therapists familiar with hemophilia). Note: Never during acute bleeding.
6. Hydrotherapy (aquatic therapy): Exercises done in warm water (buoyancy supports the body). Example: Water walking, gentle leg lifts.
7. Education and home exercise programs: Teach safe exercise techniques. Give customized home plans.

Key Principles for Physiotherapy

- Always treat bleeds first before starting exercises.
- Pain is a warning sign – exercise must be pain-free.
- Start slowly and gently, increase intensity only when safe.
- Work closely with a hematologist and physio specialized in hemophilia care.

Appendix 1 (cont). List of questions and ChatGPT's responses

Question 4: Which manual therapy techniques are used to improve joint health in hemophilia?

ChatGPT Response: "Manual therapy can be used carefully in hemophilia, but only under certain conditions (no active bleeding, stable joint, trained therapist).

1. Soft tissue mobilization (massage): Gentle, slow strokes (effleurage). Deeper techniques (petrissage) only if there's no bleeding risk. Target areas: Muscles around affected joints (e.g., quadriceps, calf muscles).
2. Passive joint mobilizations: Grade I–II mobilizations (small amplitude, non-painful movements). Focus on accessory movements (glides, small oscillations). Example: Gentle knee joint gliding or ankle dorsiflexion mobilization.
3. Myofascial release: Very light, sustained pressure techniques over muscles and fascia. Important: Deep or aggressive release is avoided.
4. Manual stretching: Slow, passive stretches within a pain-free range. Example: Stretching hamstrings while keeping the knee slightly bent if needed.
5. Lymphatic drainage techniques: Very light, rhythmic strokes along lymphatic pathways. Used Especially After: Acute bleeds, to help resolve joint effusions.

Critical safety rules for manual therapy

- Never during acute bleeding or immediately after a large hemarthrosis
- Always pain-free – pain signals possible micro-bleeding
- Low-force, high-control movements
- Close monitoring – stop if any swelling, warmth, or unusual pain appears
- Must be done by a therapist experienced in hemophilia care.

Question 5: What types of exercises are recommended to improve joint health in hemophilia?

Improving joint health in hemophilia is a multi-faceted approach, and exercise plays a crucial role in maintaining joint function and preventing long-term damage.

1. Range of motion (ROM) Exercises: Passive ROM (by therapist) in the early stages after a bleed if the joint is swollen or painful. Active ROM (self-movement) once swelling and pain subside. Example: Elbow flexion and extension (bending and straightening the arm). Ankle dorsiflexion and plantarflexion (moving the foot up and down).
2. Strengthening exercises: Isometric exercises (muscle contraction without joint movement) early in recovery. Gradually progress to concentric and eccentric strengthening (muscle shortening and lengthening) as the joint stabilizes. Example: Isometric quadriceps setting, leg raises, and resistance band exercises for upper and lower limbs to strengthen key muscles.
3. Proprioception and balance training: Work on balance by standing on one leg or using balance boards. Progress to more complex exercises like standing on foam surfaces or using a wobble board to challenge stability. Example: Standing on one leg for 20–30 s, alternating legs. Heel-to-toe walking.
4. Low-impact aerobic exercise: Use low-impact activities that avoid joint strain but provide cardiovascular benefits. Example: swimming, cycling, walking.
5. Stretching exercises: Gentle static stretching once the joint is pain-free (no aggressive stretching during a bleed or in acute recovery). Focus on muscle groups around the most affected joints. Example: Hamstring stretch (lying down, extend leg and gently pull toward the chest). Quadriceps stretch (standing, pulling foot toward the glutes).
6. Aquatic therapy (Hydrotherapy): Perform gentle strengthening, stretching, and aerobic exercises in water. Example: Walking or jogging in chest-deep water. Leg lifts or squats in water, where the buoyancy reduces the impact on the joints.
7. Functional movement training: Train movements required for daily tasks (walking, stair climbing, etc.) in a controlled manner. Gait training or using assistive devices if necessary. Example: Step-ups: To simulate walking up stairs. Sit-to-stand exercises: To mimic rising from a seated position.

Key principles for exercise

- Pain-Free: Exercises should never cause pain – pain could indicate micro-bleeding
 - Progress gradually: Start with low intensity and build up over time
 - Safety first: Avoid high-impact or risky activities (e.g., contact sports, running on hard surfaces)
 - Consistency: Regular exercise prevents muscle weakness and joint problems.
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Appendix 1 (cont). List of questions and ChatGPT's responses

Question 6: If I do not receive physiotherapy treatment for joint health, what changes will occur in my body in the long term?

1. Joint damage (hemophilic arthropathy): Repeated joint bleeds can lead to chronic inflammation and cartilage damage over time. Without physiotherapy to strengthen muscles and maintain joint function, these changes can worsen. Effect: Joint deformities (e.g., flexion contractures, joint misalignment). Loss of joint space due to cartilage degradation. Severe pain and reduced range of motion.
2. Muscle weakness and atrophy: Without proper strengthening exercises, the muscles around affected joints weaken, leading to muscle atrophy (wasting). Weak muscles cannot support joints effectively, increasing the risk of further injury. Effect: Muscle weakness in areas like the thighs, calves, and upper arms. Increased risk of joint instability and frequent bleeds because muscles are not providing enough protection. Reduced overall mobility and difficulty performing daily activities.
3. Loss of range of motion (contractures): Without physiotherapy to maintain or restore flexibility, joints can become stiff, and surrounding tissues may shorten (leading to contractures). Effect: Loss of mobility in critical joints like elbows, knees, and ankles. Difficulty with basic movements such as bending, straightening, or walking. Permanent joint deformities if left unchecked.
4. Increased risk of future bleeding: As muscles weaken and joints become unstable, the risk of accidental falls or movements that lead to new joint bleeds increases. The lack of physiotherapy may prevent the proper muscle reinforcement that would otherwise protect joints. Effect: More frequent and severe bleeding episodes. A vicious cycle of repeated bleeds causing ongoing damage and dysfunction.
5. Chronic pain and inflammation: Without regular physiotherapy, the damaged joints and muscles remain unaddressed, causing chronic pain, swelling, and inflammation. Effect: Persistent joint pain that worsens with activity or weather changes. Inability to manage pain without consistent physical therapy to address underlying joint dysfunction.
6. Decreased quality of life: All of the above effects accumulate over time, reducing your ability to participate in daily activities, work, or recreational activities. The lack of mobility and persistent pain can lead to social isolation or depression. Effect: Inability to engage in exercise or low-impact activities (e.g., swimming, walking). Difficulty performing tasks such as household chores, climbing stairs, or even walking. Emotional and mental health struggles due to ongoing disability and pain.
7. Early onset of joint replacement needs: If joint health deteriorates significantly without physiotherapy, severe joint damage may lead to the need for joint replacement (e.g., knee or hip replacement) earlier than in those with regular joint care. Effect: Need for surgical interventions like joint replacements or synovectomies to manage pain and disability. A longer recovery process from these surgeries, especially if the body is weakened due to lack of physiotherapy.

Question 7: What are the potential risks of physiotherapy applications in hemophilic individuals?

Physiotherapy must be approached cautiously due to the unique risks involved. Improper or aggressive physiotherapy can lead to complications due to the bleeding tendency inherent in hemophilia.

1. Increased risk of bleeding: Hemophilic individuals are more prone to bleeding, even with minor trauma or intense physical activity. Aggressive or high-impact physiotherapy can cause soft tissue or joint bleeds. Example: Excessive stretching, mobilizations, or joint manipulations may cause small tears in tissues or increased joint pressure that can trigger a bleed.
2. Joint damage due to excessive force: High-velocity or aggressive manual therapy (e.g., deep joint mobilizations) or exercises involving high resistance can lead to joint trauma. Example: Improper techniques like high-impact stretching or sudden movements may worsen existing joint damage (hemophilic arthropathy).
3. Overloading the joint or muscle: Pushing too hard in strengthening exercises, especially if muscles are already weak from previous bleeds, can overload the joint and cause additional stress, potentially leading to micro-tears or joint damage. Example: Lifting too much weight or performing excessive repetitions during strengthening exercises can lead to strain or even more severe joint injuries.
4. Incorrect timing of exercise: Physiotherapy must be carefully timed in relation to bleeding episodes. Exercising too soon after a bleed (before swelling or pain is under control) can worsen the condition. Example: Early mobilization after a joint bleed, without allowing enough time for factor replacement and rest, could lead to further bleeding or joint instability.
5. Increased pain and swelling: Physiotherapy can sometimes irritate the tissues around a healing joint or muscle, especially if exercises are performed too intensely or too soon. Example: Too much stretching or joint mobilization can cause swelling, discomfort, or additional pain, especially in joints that are already inflamed or healing from a bleed.
6. Risk of overuse injuries: Repeating certain movements or exercises incorrectly (without proper supervision or technique) can lead to overuse injuries, particularly in weakened joints or muscles. Example: Repetitive strain from improper posture or poor biomechanics during exercises can increase the risk of injury or joint irritation, especially in those with pre-existing joint damage.
7. Lack of qualified supervision: Physiotherapy should ideally be performed under the supervision of a trained physiotherapist who is experienced in working with individuals with hemophilia. Inadequate supervision or incorrect modifications to exercises can lead to injuries or improper progression of treatment. Example: A physiotherapist unfamiliar with hemophilia might recommend exercises that are too aggressive or don't take the unique bleeding risks into account.

Preventive measures to minimize risks

1. Personalized exercise plans: Exercise programs must be tailored to the individual's bleeding history, joint condition, and overall health. Low-impact and joint-protective exercises are preferred (e.g., water therapy, cycling).
2. Slow and gradual progression: Any strengthening or stretching program should start slowly and progressively increase intensity, ensuring muscle recovery after each session.
3. Avoid high-impact or high-risk movements: Avoid activities that risk falls, bruises, or high joint stress (e.g., heavy lifting, high-intensity sports, sudden jerky movements).
4. Always monitor pain and swelling: Regular monitoring of pain levels and swelling during and after therapy is crucial. Any noticeable increase in these should be a signal to modify or stop the exercise.
5. Factor replacement before therapy: If a bleeding episode occurred, ensure proper factor replacement before beginning physiotherapy to reduce bleeding risks.
6. Frequent communication with medical providers: Keep open communication with the treating hematologist, as they can offer guidance on how to safely proceed with physiotherapy, including timing and intensity adjustments after bleeding events.

Appendix 1 (cont). List of questions and ChatGPT's responses

Question 8: What should be the duration and frequency of physiotherapy for joint health in hemophilic individuals?

For individuals with hemophilia, maintaining joint health with physiotherapy is a lifelong need, not just a short treatment.

Duration:

- Continuous/lifelong: Physiotherapy should be part of their routine health care forever
- Specific sessions (like after a bleed, injury, or surgery) can last several weeks to months, depending on recovery
- Even when there is no active joint problem, ongoing maintenance exercises are important to prevent new bleeds and arthropathy.

Frequency:

- In stable periods (no acute bleed):
- Supervised physiotherapy: Typically 1–2 times/week (e.g., in a hospital or clinic) for assessments, correction of techniques, and adjustments.
- Home exercise program: Daily or 4–5 times/week, focusing on strength, flexibility, and proprioception.

After an acute joint bleed or surgery:

- Initially, more frequent: Physiotherapy can be daily or every other day early on, then taper as healing progresses.
- For children (especially): Include fun activities such as swimming, cycling, or controlled sports to improve adherence and promote joint health.

Important conditions:

- Always coordinate exercises with factor replacement therapy if needed (do physical activity when clotting factor levels are optimal)
- Avoid high-impact or risky activities that could cause joint trauma.

Summary: Lifelong daily exercises at home + 1–2 supervised physiotherapy sessions per week, adjusted during special periods like after bleeds or surgery.

Question 9: Does fitness or physical activity improve joint health in hemophilia?

Fitness and physical activity can significantly improve joint health in PwH, provided the activities are carefully chosen and adapted to avoid excess strain or injury. However, it is essential to choose low-impact activities and monitor intensity to avoid causing bleeding or joint damage.

1. Strengthening muscles around the Joints: Provides stability and reduces the stress placed on the joint itself, especially when the muscles are weak due to repeated bleeds or immobility.
2. Increasing joint mobility: Range of motion (ROM) exercises help maintain joint flexibility and prevent contractures and stiffness that can result from hemophilia-related joint damage.
3. Improving proprioception (joint awareness): Proprioception exercises (exercises that focus on balance and body awareness) improve the sense of joint position, which is crucial for preventing joint injuries and falls. This is especially important for preventing the risk of injury during everyday movements or physical activities.
4. Reducing the risk of further bleeding: Regular physical activity helps improve circulation and blood flow, which can support overall vascular health. This can reduce the likelihood of small bleeds in the joint (hemarthrosis) as the body becomes more efficient in managing circulation and repairing damage.
5. Pain reduction and improved function: Regular movement and exercise can help reduce joint pain by enhancing the fluid dynamics within the joint, improving muscle strength, and increasing mobility. Strengthening the muscles surrounding the joint also reduces the mechanical load on the joint itself, potentially decreasing pain over time.
6. Preventing obesity and overloading of joints: Weight management is essential for individuals with hemophilia. Excess weight puts additional strain on the joints, especially the lower body (hips, knees, and ankles), increasing the risk of joint wear and tear. Regular physical activity helps in maintaining a healthy body weight, thus reducing joint load.

Precautions

1. Avoid high-impact activities: Running, jumping, contact sports, or activities with a high risk of falls (e.g., basketball, soccer) should be avoided as they can lead to bleeding episodes.
 2. Start slowly: Begin with gentle movements, gradually increasing intensity and duration based on tolerance and joint condition.
 3. Pain-free movements: Ensure exercises are pain-free. Pain during or after exercise may indicate strain or a possible bleed.
 4. Monitor Swelling and Bruising: If any swelling, bruising, or discomfort occurs during or after an exercise session, adjust the intensity or take a break to allow recovery.
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Appendix 1 (cont). List of questions and ChatGPT's responses

Question 10: When should physiotherapy be started after orthopedic surgery in hemophilia?

Physiotherapy is typically started as soon as it is safe to do so. The exact timing depends on the type of surgery, the severity of hemophilia, and the individual's recovery progress.

1. Immediately post-operative phase (0–48 h): Focus is on managing swelling, pain, and preventing complications such as joint stiffness or muscle atrophy. This period may involve gentle movements and techniques to ensure that the surgical site remains stable and protected.
2. Early rehabilitation (3–7 days): Physiotherapy can begin with light, passive range-of-motion exercises, and muscle activation if the surgeon agrees. Hemophilia patients need to be closely monitored to avoid bleeding or joint damage, so exercises must be carefully controlled.
3. After 2 weeks: If there are no significant complications, more active rehabilitation can begin, which may include strengthening exercises, weight-bearing activities, and improving flexibility. The intensity of the exercises should be progressively increased under careful supervision.

It is crucial to tailor the rehabilitation plan to the individual's condition, monitor for any bleeding episodes, and ensure that factor replacement therapy is managed to avoid complications. Always follow the advice of the treating orthopedic surgeon and hemophilia care team.
