

The effectiveness of continuous passive motion (CPM) following total knee arthroplasty

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CLINICAL SCENARIO: Continuous Passive Motion (CPM) has been utilized as part of routine treatment following knee arthroplasty since the 1980s. One of the benefits of CPM is thought to be improved knee flexion, however in recent years this has been questioned (Harvey, Brosseau, & Herbert 2014). Despite this, surgeons continue to order CPM treatment and patients often ask whether CPM would be beneficial for them, either in place of or in conjunction with their prescribed active exercises.

FOCUSED CLINICAL QUESTION:

Is continuous passive motion (CPM) as effective as active range of motion (ROM) in increasing knee ROM after total knee arthroplasty?

SUMMARY of Search, 'Best' Evidence' Appraised, and Key Findings:

Many studies have been published on this topic; this search was limited to the past five years to obtain the most recent findings. The five best articles included two systematic reviews and three randomized controlled trials.

The randomized controlled trial by Herbold et al., (2014) examined the use of CPM for individuals with poor flexion ROM following total knee replacement. The authors found no significant difference in knee flexion ROM between patients who had CPM versus those who had standard therapy. The randomized controlled trials by Boese et al., (2014) and Maniar, Baviskar, Singhi & Rathi, (2012) also found that the use of CPM did not result in greater knee flexion than standard therapy.

Systematic reviews by Harvey et al., (2014) and Viswanathan & Kidd, (2010) reported no significant improvement in knee flexion ROM with the

use of CPM. Viswanathan et al., (2010) stated there was no evidence to support the use of CPM in achieving long-term benefits in knee ROM, while Harvey et al., (2014) concluded that the effects of CPM on ROM are too small to justify its use. Harvey et al., (2014) stated that further trials to determine the effect of CPM on knee ROM are not recommended, suggesting that the overall evidence is clear; CPM is not beneficial.

CLINICAL BOTTOM LINE:

Research evidence does not support the use CPM to improve knee ROM following total knee arthroplasty.

Limitation of this CAT: This critically appraised paper (or topic) was prepared for a graduate course assignment and has been reviewed by two instructors.

SEARCH STRATEGY:

Terms used to guide Search Strategy:

- **P**atient/Client Group: Patients with total knee arthroplasty
- **I**ntervention (or Assessment): Continuous passive movement
- **C**omparison: Active exercise
- **O**utcome(s): Active ROM

Databases and Sites Searched	Search Terms	Limits Used
CINAHL MEDLINE (Ovid SP) Embase	MeSH terms: MH Arthroplasty, Knee Key words: total knee arthroplast*, total knee replacement* AND MeSH terms: MH Motion Therapy, continuous passive	Published 2010-2015.

	Key words: continuous passive movement, continuous passive motion, CPM	
PEDro	Key words: Knee arthroplast* AND Continuous passive motion	Published 2010-2015.
Cochrane Library	Key words: Knee arthroplasty AND Continuous passive motion	

INCLUSION and EXCLUSION CRITERIA

- Inclusion:
 - CPM compared to active exercise
 - Active ROM one of the key outcomes measured
- Exclusion:
 - Language other than English
 - Published before 2010
 - Opinion articles
 - Narrative reviews

RESULTS OF SEARCH

Eight relevant studies were located and categorised as shown in Table 1:

Table 1: Summary of Study Designs of Articles Retrieved

Study Design/ Methodology of Articles Retrieved	Level*	Number Located	Author (Year)
Systematic review	1	2	Harvey et al., (2014) Viswanathan & Kidd (2010)

Randomized controlled trial	2	3	Herbold et al., (2014) Boese et al., (2014) Maniar et al., (2012)
Non-randomized controlled trial	3	2	Tabor et al., (2013) Chen et al., (2012)
Matched cohort study	3	1	Herbold et al., (2012)

*OCEBM Levels of Evidence Working Group. "The Oxford 2011 Levels of Evidence". Oxford Centre for Evidence-Based Medicine.
<http://www.cebm.net/index.aspx?o=5653>

BEST EVIDENCE

The following study (Herbold et al., 2014) was identified as the 'best' evidence and selected for critical appraisal. Reasons for selecting this study were:

- Relates directly to the PICO question.
- Primary outcome measure is active knee flexion ROM.
- Randomized controlled trial.
- Published in 2014.
- Intervention studied in a rehabilitation setting rather than an acute care setting – while not specified in the PICO question it is relevant to the writer's practice.

SUMMARY OF BEST EVIDENCE

Table 2: Description and appraisal of Randomized controlled trial of the effectiveness of continuous passive motion after total knee replacement by Herbold, J.A., Bonistall, K., Blackburn, M., Agolli, J., Gaston, S., Gross, C., Kuta, A., & Babyar, S. (2014).

Aim/Objective of the Study:

The purpose of this study was to determine the effect of standard therapy + CPM compared with standard therapy alone for patients with poor ROM after total knee arthroplasty who were admitted for post-acute rehabilitation.

Study Design:

The study was a randomized controlled trial. Participants meeting the inclusion criteria were enrolled consecutively. Subjects were randomly assigned to either the experimental group (CPM) or control group

(standard therapy) based on a unique account number. Neither the therapists nor the patients were blinded to the treatment. Outcomes were measured on admission to the rehabilitation facility and the day before discharge. One survey (WOMAC) was mailed to patients one week following discharge.

Setting:

The study took place in one inpatient rehabilitation facility between November 2011 and November 2012. All patients had been transferred directly to the facility within five days following surgery.

Participants:

There were 141 subjects (99 women and 42 men). The average age was 72+/-7 years. Inclusion criteria included single knee replacement, diagnosis of knee osteoarthritis, age 40-80 years, initial knee flexion between 45° and 75°, and body mass index <40. Exclusion criteria included revision of a previous knee replacement, bilateral knee replacement and comorbid medical conditions that could complicate recovery. The study was given approval by an institutional review board and written informed consent was obtained from the participants.

There were 70 participants in the experimental group and 71 in the control group. Baseline clinical measurements and demographic characteristics were similar between groups.

Table 2a: Baseline clinical characteristics

VARIABLES	CPM GROUP (N=70)	CONTROL GROUP (N=71)
Initial range of motion (degrees)		
Active flexion	61.3+/-7.8	63.6+/-7.4
Active extension	-4.7+/-4.7	-4.6+/-3.3
Initial FIM		
Motor score	43.2+/-4.7	42.7+/-4.1
Cognitive score	28.0+/-1.6	28.1+/-1.6
Total FIM score	71.3+/-5.5	70.8+/-4.7
Initial knee girth (cm)	47.0+/-5.9	46.5+/-5.4
Initial WOMAC		
Pain subscale	10.2+/-3.6	10.6+/-3.5
Stiffness subscale	4.6+/-1.4	4.7+/-1.5
ADL difficulty	35.3+/-11.8	34.4+/-12.0
Total score	50.2+/-15.7	50.3+/-15.0
Initial TUG (seconds)	39.3+/-15.6	40.9+/-18.8
Pre-surgical ambulation		

device		
Walker or Cane	17 (24)	22 (31)
No device	53 (76)	49 (69)

Initially 145 subjects were recruited. Four were unable to complete the study (CPM was unavailable for two patients; one did not like CPM and one reported skin irritation from the pads). Information collected from these four patients was not included. At follow up, only 55% of the WOMAC surveys were returned by the participants.

Intervention/Phenomenon Investigated:

The control group received standard therapy consisting of three hours of physical and occupational therapy per day. The authors did not define what types of treatment (exercise, functional activity, manual therapy) occurred during these sessions. The experimental group received the same standard therapy as the control group plus two hours of CPM daily. The CPM machine was set based on the maximum flexion tolerated on the day of admission and extension was set to 0°. Patients were allowed to stop the machine if they experienced discomfort.

Outcome Measures/Qualitative Methods

The primary outcome measure was active knee flexion ROM. Range of motion was measured with the patient in a supine position using a universal goniometer in a standardized fashion. The authors noted that inter-rater reliability for knee ROM has been reported to be high for flexion.

Secondary outcome measures:

- 1) Active knee extension ROM, measured in the same manner as knee flexion. The authors noted that inter-rater reliability for extension ROM has been reported as fair to good.
- 2) Timed up and go (TUG) was used as a functional measure. The patient rose from a chair with arms, walked 3 meters, turned around, walked back to the chair and sat down. Patients were given standard instructions and were allowed to use a walking aid.
- 3) Knee circumference was measured using a standard tape measure at the joint line to indicate the amount of joint swelling. The authors noted that inter-rater reliability of this measure is high.
- 4) The Functional Independence Measure (FIM) was used as a measure of function. The authors described the FIM as "a well standardized measure used to estimate the burden of care associated with 18 functional and cognitive items" (Herbold et al., 2014 p.1242).
- 5) The ambulation device was recorded as no device, single cane, bilateral cane, crutches or walker.
- 6) Length of stay was calculated by subtracting the discharge date from the date of admission.

7) The WOMAC "is a self-report measure assessing patient's perception of their pain, stiffness and ability to perform ADL" (Herbold et al., 2014 p. 1242).

Main Findings:

There was no significant difference in active flexion ROM between the CPM group and the control group. There was no significant difference between the groups on the secondary outcome measures including extension ROM, total FIM score, TUG, girth measurements and follow up WOMAC scores.

Table 2b: Results

OUTCOME VARIABLES	CPM GROUP (N=70)	CONTROL GROUP (N=71)	P VALUE
Active flexion	83.5+/-10.0	86.4+/-7.9	.080
Active extension	-2.7+/-2.8	-3.3+/-3.3	.211
Total FIM score	107+/-4.1	107.8+/-3.2	.146
Knee girth	46.1+/-5.3	46.2+/-5.0	.175
TUG score	19.9+/-7.5	19.8+/-6.1	.532
WOMAC score	30.2+/-14.6	33.3+/-14.4	.294

The authors found that length of stay for both groups averaged 8 days (CPM mean was 8.3+/-1.7, Control mean was 8.7+/-2.7, $P < .311$). Most patients were discharged home using a cane (87% for the control group, 90% for the CPM group) with no statistical difference between the groups ($P < .792$).

Original Authors' Conclusions:

The authors concluded there was no significant benefit of standard care plus CPM compared with standard care alone during post-acute rehabilitation. Since there was no benefit of CPM for any of the outcome measures, the routine use of CPM was discontinued at their treatment facility.

Critical Appraisal:

Study purpose: The purpose was clearly stated.

Literature: A thorough literature review was completed. The authors identified no previous studies that looked at patients in an inpatient rehabilitation facility who are most at risk for poor knee ROM.

Design: A randomized controlled trial is the best study design to answer a question about an intervention (Hoffmann et al., 2013). Since both groups received treatment, no ethical issues were identified.

Validity:

PEDro score: 6/10. Eligibility criteria: Yes; Random allocation: Yes; Concealed allocation: No; Baseline comparability: Yes; Blind Subjects: No; Blind therapists: No; Blind assessors: No; Adequate follow up: Yes; Intention to treat analysis: Yes; Between group comparisons: Yes; Point estimates and variability: Yes.

Bias:*Measurement Bias*

Neither the participants nor the therapists were blinded to the treatment. The interdisciplinary team, which determined the discharge date and destination for each subject, was blinded to the group assignment.

The inter-rater reliability of the assessors for ROM measurements was not examined prior to the study, so it is possible that there was a greater margin of error than predicted.

Attrition Bias

Only 55% of the WOMAC surveys were returned (34 control and 40 CPM). No mention was made of how this missing data was accounted for in the analysis.

Intervention Bias

The participants were assigned to a primary therapist at admission, but it was not specified if the primary therapist performed all of the treatment. It was not specified who applied the CPM (nursing staff, therapy staff). There could be bias if different people applied the treatment over the course of the study.

The CPM treatment was not standardized. Subjects were allowed to turn down the flexion if they had discomfort, and the subjects were allowed to terminate the CPM treatment prior to the full time allotted. The treatment effect may have been underestimated if subjects did not use the machine to its full potential.

Sample: The participants were randomly assigned to treatment or control groups, based on a unique account number. It is unclear whether the allocation was concealed. The criteria for inclusion and exclusion were clearly described. Baseline characteristics between groups were similar. The study was adequately powered (a prospective power calculation determined a minimum sample size of 130 (65 per group)). Ethics procedures including informed consent and approval from the Institutional Review Board were followed.

Outcomes: The outcome measures chosen were appropriate. The authors did not specifically address the validity and reliability of each outcome

measure, but each outcome is commonly used in rehabilitation after total knee replacement.

Intervention: Both the control group and the experimental group received three hours per day of standard physical and occupational therapy. The authors did not describe what the therapy entailed. In the discussion section, the authors refer to inpatient rehabilitation as “promoting movement and functional recovery” (Herbold et al., 2014 p.1243). One may assume treatment was a combination of active exercise and functional activities, yet it would not be possible to replicate this study. The experimental group received standardized therapy with the addition of two hours per day of CPM. As mentioned previously, patients could control the flexion setting and the amount of time the machine was used.

Interpretation of Results:

The groups were similar at baseline. The statistical analysis was appropriate. Both groups showed a significant improvement in each of the outcome measures from admission to discharge, but the difference between the groups on each outcome measure was not significant.

This study population was consistent with patients who have had total knee replacement and require ongoing rehabilitation. The outcomes measured are commonly utilized in practice. Although the authors did not specify the treatment provided, the transferability of this study is reasonably good. Limitations in the study include lack of blinding, lack of standardization with CPM use and low response rate on the follow up WOMAC scale.

Summary/Conclusion:

The results showed no significant difference between the groups, suggesting that standard physical therapy alone is effective at improving knee flexion ROM after total knee replacement. The addition of CPM to standard therapy did not provide any further benefit to ROM or any of the other outcomes measured. Despite the limitations in the study design, the conclusion drawn by the authors is appropriate.

IMPLICATIONS FOR PRACTICE, EDUCATION and FUTURE RESEARCH

The results of this study are consistent with the current literature. The systematic review by Harvey and colleagues (2014) also concluded that the effects of CPM on ROM, pain, function and quality of life are too small to justify its use. Harvey et al. (2014) argued that further trials to examine the effect of CPM on knee ROM are not recommended. Since bias tends to favour the effectiveness of treatment, the true effect of CPM is likely even less than has been reported. In their studies, Boese et al.

(2014) and Maniar et al. (2012) found CPM use did not yield greater knee ROM compared with standard therapy alone. As a result, the routine use of CPM was discontinued in each of their facilities. The literature is quite clear; CPM provides no additional benefit to routine rehabilitation after knee arthroplasty. Implications for practice include informing clients that CPM is not effective and having discussion with surgeons who continue to order CPM for their patients.

REFERENCES

- Boese, C.K., Weis, M., Phillips, T., Lawton-Peters, S., Gallo, T., & Centeno, L. (2014). The efficacy of continuous passive motion after total knee arthroplasty: A comparison of three protocols. *The Journal of Arthroplasty*, *29*(6), 1158-1162. doi: 10.1016/j.arth.2013.12.005
- Chen, L., Chen, C, Lin, S., Chien, S., Su, J.Y., Huang, C., ... Huang, H. (2012). Aggressive continuous passive motion exercise does not improve knee range of motion after total knee arthroplasty. *Journal of Clinical Nursing*, *22*(3), 389-394. doi: 10.1111/j.1365-2702.2012.04106x
- Harvey, L.A., Brosseau, L., & Herbert, R.D. (2014). Continuous passive motion following total knee arthroplasty in people with arthritis. *Cochrane Database of Systematic Reviews*, *2012*(2), 1-125. doi: 10.1002/14651858.CD004260.pub3
- Herbold, J.A., Bonistall, K., & Blackburn, M. (2012). Effectiveness of continuous passive motion in an inpatient rehabilitation hospital after total knee replacement: A matched cohort study. *Physical Medicine and Rehabilitation*, *4*(10), 719-725.
- Herbold, J.A., Bonistall, K., Blackburn, M., Agolli, J., Gaston, S., Gross, C., ... Babyar, S. (2014). Randomized controlled trial of the effectiveness of continuous passive motion after total knee replacement. *Archives of Physical Medicine and Rehabilitation*, *95*(7), 1240-1245. doi: 10.1016/j.apmr.2014.03.012
- Hoffmann, T., Bennett, S., & Del Mar, C. (2013). *Evidence based practice across the health professions* (2nd ed.), Sydney, Australia: Elsevier
- Maniar, R.N., Baviskar, J.V., Singhi, T., & Rathi, S.S. (2012). To use or not to use continuous passive motion post-total knee arthroplasty. Presenting functional assessment results in early recovery. *Journal of Arthroplasty*, *27*(2), 193-200.e1. doi: 10.1016/j.arth.2011.04.009

OCEBM Levels of Evidence Working Group*. "The Oxford Levels of Evidence 2". Oxford Centre for Evidence-Based Medicine.
<http://www.cebm.net/index.aspx?o=5653>

**OCEBM Levels of Evidence Working Group = Jeremy Howick, Iain Chalmers (James Lind Library), Paul Glasziou, Trish Greehalgh, Carl Heneghan, Alessandro Liberati, Ivan Moschetti, Bob Phillips, Hazel Thornton, Olive Goddard and Mary Hodgkinson*

Tabor, D. (2013). An empirical study using range of motion and pain score as determinants for continuous passive motion: Outcomes following total knee replacement surgery in an adult population. *Orthopaedic Nursing, 32*(5), 261-265.
doi: 10.1097/NOR.0b013e3182a3016a

Viswanathan, P., & Kidd, M. (2010). Effect of continuous passive motion following total knee arthroplasty on knee range of motion and function: A systematic review. *New Zealand Journal of Physiotherapy, 38*(1), 14-22.
