**Harvey LA, Brosseau L, and Herbert RD. Continuous passive motion following total knee arthroplasty in people with arthritis (Review). Cochrane Database of Systematic Reviews 2014, Issue 2. Art # CD004260.**

**Design:** Meta-analysis of randomized clinical trials
**Date:** 11-26-14 LM

**Study Question:** To assess the benefits and harms of continuous passive motion (CPM) and standard postoperative care versus similar postoperative care, with or without additional knee exercises, in people with knee arthroplasty.

**PICOs:**

- Patients: Any age persons diagnosed with knee arthritis prior to total knee arthroplasty in a hospital
- Interventions: CPM and standard postoperative care such as muscle strengthening exercises
- Comparison interventions: Similar postoperative care with or without additional knee exercises. Additional knee exercises could include instructions or supervised active or passive knee ROM exercises, but not on a CPM device.
- Outcomes: Pain, function, active knee flexion ROM, and quality of life
    - Pain was measured by visual analogue scale (VAS), 0-10, lower score better
    - Function was measured using various scales, 0-100, higher score better
    - Active knee flexion ROM, goniometer, $0\text{-}130^0$
    - Quality of life, physical component subscore of the Short-Form 12-Item Health Survey (SF-12) from 0-100, higher score better
    - Timing of outcomes was short term (< 6 weeks) for pain and active knee flexion ROM, and medium term (6 weeks to 6 months) for function and quality of life after randomization
- Study types: Randomized clinical trials comparing CPM and standard postoperative care with similar postoperative care with or without additional knee exercises

**Study selection:**

- Databases included MEDLINE, CINAHL, AMED, PEDro and EMBASE through January 24, 2013 and the Cochrane Central Register of Controlled Trials through 2012, Issue12.
    - Reference lists of included trials were also checked
- Two authors independently assessed articles on trial quality for inclusion and extracted data from the trials, resolving any disagreements through consensus
- Risk of bias was assessed using the method recommended by the Cochrane Reviewer's Handbook which uses the following criteria; adequate sequence generation, allocation concealment, blinding of participants, providers, and outcome

assessors, incomplete outcome data and follow-up data addressed, selective outcome reporting, and other potential sources of bias.

- Mean differences (MDs) in outcomes from each trial were pooled to obtain a summary estimate of the effectiveness of CPM. The effect of CPM was estimated by taking the difference in the mean outcome of the groups that did and did not receive CPM.
- Heterogeneity in meta-analysis was graded with the $I^2$ statistic: from 0 to 40% might not be important; from 30 to 60% may mean moderate heterogeneity; from 50 to 90% may mean substantial heterogeneity, and from 75 to 100% was considerable heterogeneity. Data was not pooled if $I^2$ was greater than 50%. Only random-effects models were used.
- The authors planned no subgroup or sensitivity analyses, but looked for small sample bias comparing results between the random-effects model and fixed-effect model of analyses for each outcome.

**Results:**

- 24 studies were included with 1335 people randomized
- Potentially eligible trials were most commonly excluded because the control group received something other than usual care with or without additional exercises.
- Four new studies since 2010 were included in this update
- CPM was administered from 1.5 to 24 hours a day (median 5.7), and for between 1 and 17 days (median 8). CPM treatments were initiated between the 1$^{st}$ and 4$^{th}$ postoperative day in all trials except one.
- Most patients had OA rather than rheumatoid arthritis.
- Many of the 24 trials were vulnerable to bias because the criteria used to assess methodological quality were not always satisfied.
    - 4 trials did not satisfy any of the criteria
    - None of the trials blinded patients or treating therapists (not easy with CPM)
    - 16 trials did not conceal allocation
    - 16 trials did not use random sequence generation
    - Selective reporting was present in 16 trials
    - 8 trials had incomplete reporting
    - 14 trials did not blind assessors
    - 8 trials did not have complete outcome data
- There was moderate-quality evidence from 10 studies (470 participants) showing that CPM does not have statistically significant or clinically important short-term effects on active knee flexion ROM. The mean knee flexion was 78 degrees in the control group, and 80 degrees in the CPM group. The mean difference was 2 degrees with increased active knee flexion ROM in the CPM group (95% CI = 0 to 5; $I^2$ = 43%). There was considerable between-study heterogeneity in estimates of medium-term effects ($I^2$ = 69%) and long-term effects ($I^2$ = 54%), so data was not pooled.

- There was moderate-quality evidence from 6 studies (405 participants) showing that CPM does not have statistically significant or clinically important medium-term effects on function. The mean function in the control group was 57.6 points and 56 points in the CPM group. CPM decreased function by 1.6 points (95% CI = -6.1 to 2.0) on a 100-point scale. The SMD was -0.1 standard deviations (SD) with less function for the CPM group (95% CI = -0.3 to 0.1; $I^2$=0%). There was considerable between-study heterogeneity in estimates of short-term effects ($I^2$ = 72%), so data was not pooled.
- There was moderate-quality evidence from 2 studies (156 participants) showing that CPM does not have statistically significant or clinically important medium-term effects on quality of life. Mean quality of life was 40 points in the control group, and 41 points in the CPM group. CPM improved quality of life by 1 point on a 100-point scale (95% CI = -3 to 4). There was insufficient data for pooling of both long and short term effects.
- There was only low-quality evidence from 8 trials (414 participants) showing that CPM does not have statistically significant or clinically important short-term effects on pain. Mean pain was 3 points in the control group, and 2.6 points in the CPM group. CPM reduced pain by 0.4 points on a 10-point scale (95% CI = -0.8 to 0.1). The mean difference of -0.4 points resulted in less pain for the CPM group ($I^2$ = 50%). There was considerable between-study heterogeneity in estimates of medium-term effects ($I^2$ = 52%), so data was not pooled. There was insufficient data for pooling of long-term effects.
- Seventeen trials reported on adverse events. Adverse events included delayed healing, hemarthrosis, falls, deep venous thromboses, wound infections, pulmonary emboli, knee hematoma and a patellar rupture. There were 178 adverse events in total. The RR was 0.92 with less risk for the CPM group (95% CI = 0.63 to 1.33; $I^2$ = 39%).

**Authors' conclusions:**

- The effects of continuous passive motion (CPM) on range of motion (ROM), pain, function, and quality of life are too small and clinically unimportant to justify its use and costs.
- The moderate-quality evidence showing that CPM does not have any short-term effects on active knee flexion ROM is fairly precise. The evidence was only downgraded from high to moderate because of the susceptibility of the included trials to bias, particularly bias from not using concealed allocation and blinded assessors. However, bias tends to inflate estimates of treatment effectiveness. Therefore, the real estimate is probably even less that reported in this review. In addition, the findings from passive knee flexion, active knee extension and passive knee extension also showed no improved effects of CPM.
- The quality of evidence is only moderate for the effects of CPM on function and quality of life, because the findings on these outcomes were only based on a small number of trials. More evidence may be warranted to support this conclusion.
- This Cochrane review should only be updated if new evidence emerges that is likely to substantially change the conclusions of this review or shift the quality of evidence

supporting the conclusions to high. However, it is unlikely that additional trials will change the conclusions about ROM, because these estimates are reasonably precise and consistent, and we anticipate that with better quality trials the treatment effects will be smaller, not greater. If CPM does not affect knee joint ROM, then it is most unlikely that CPM will affect any other outcomes because CPM is primarily prescribed on the basis of its benefits on knee joint ROM. With no effect on knee joint ROM, there are no obvious mechanisms for CPM to affect other outcomes.

- CPM may no longer be a viable or appropriate treatment option, regardless of findings, because patients are now commonly discharged within a few days of surgery and often mobilized on the same day as surgery.

**Comments:**

- CPM is primarily advocated for its proposed benefits on knee ROM, particularly knee flexion. Most people would agree that an added benefit of less than 5 degrees is functionally unimportant, and most would probably agree that considerably more than 5 degrees is required to justify the added time, cost and inconvenience of CPM. The findings in this review of 2 degrees increased active knee flexion ROM in the CPM group clearly indicates that CPM does not have clinically important short-term effects on active knee flexion ROM.
- In addition to the evidence on short-term effects for active knee flexion ROM, the medium- and long-term effects of CPM on active knee flexion ROM, passive knee flexion ROM, active knee extension ROM or passive knee extension ROM have similar effect sizes, all having mean effects less than three degrees. Importantly, the upper 95% CIs of all but one of the eight estimates of the medium- and long-term effects are less than 5 degrees. This lends further support to the conclusion that CPM does not have statistically significant or clinically important short-term effects on active knee flexion ROM.
- CPM decreased function by only 1.6 points (95% CI = -6.1 to 2.0) on a 100-point scale. A maximum added functional benefit of CPM of 2 degrees or less is clinically unimportant, and most would probably agree that considerably more than 5 degrees is required to justify the added time, cost and inconvenience of CPM.
- Many different protocols were used to administer CPM. For example, in some trials CPM was started immediately after the knee operation, whereas in other trials it was started days later. This variable may have influenced the observed effects of CPM.
- Dose dependence was tested in this review by using a meta-regression to examine effects of mean total CPM time (hours) on passive knee flexion ROM in the short term. The results indicated that the response to CPM is not dose dependent.
- Even though the co-interventions were highly variable between studies, it is unlikely that CPM would be more effective than knee exercises because the primary analysis indicated CPM is no more effective than usual care, with or without additional knee exercises.
- The heterogeneity could have been due to any number of factors but was most likely due to the use of different tools to measure function, which was measured with outcomes as diverse as self-reporting questionnaires and timed walking tests.

- Only 10 trials clearly blinded assessors. Failure to blind assessors exposes the trials to performance and detection biases. Only eight of the 24 trials concealed allocation and nearly all trials were selective in their reporting of data. These potential sources of bias led to a downgrading of the quality of evidence for all outcomes reported. However, this risk of bias presented by unblinded assessors would tend to tilt the results toward a more favorable outcome for CPM, and since the results still do not favor CPM, it only strengthens the study's conclusions.
- The findings of this review are broadly consistent with the findings of similar newer studies not included in this review (Herbold 2014; Boese 2014; Chen 2013; Herbold 2012). These authors also concluded that CPM had no effect on active knee flexion ROM or function.

**Assessment:**

High quality Cochrane meta-analysis which supports good evidence that in people with osteoarthritis of the knee, continuous passive motion following total knee arthroplasty does not have clinically important short-term effects on active knee flexion ROM or medium-term effects on function or quality of life.

**References:**

Herbold JA, Bonistall K, Blackburn M et al. Randomized controlled trial of the effectiveness of continuous passive motion after total knee replacement. Arch Phys Med Rehabil 2014; 95(7):1240-5.

Herbold JA, Bonistall K, and Blackburn M. Effectiveness of Continuous Passive Motion in an Inpatient Rehabilitation Hospital After Total Knee Replacement: A Matched Cohort Study. Physical Medicine and Rehabilitation 2012; 4:719-725.

Boese CK, Weis M, Phillips T, et al. The Efficacy of Continuous Passive Motion After Total Knee Arthroplasty: A Comparison of Three Protocols. The Journal of Arthroplasty 2014; 29:1158–1162.

Chen LH, Chen CH, Lin SY, et al. Aggressive continuous passive motion exercise does not improve knee range of motion after total knee arthroplasty. J Clin Nurs. 2013; 22(3-4):389-94.