These guidelines, treatments, and milestones have been established to assist in guiding rehabilitation based on the most current available evidence. They are not intended to be substitute for sound clinical judgement with consideration of the individual contextual features of the patient and the demands of various functions/sports.

**Pre-operative goals:** Full knee extension range of motion (ROM), absent or minimal joint swelling, no knee extension lag with straight leg raise (SLR), educate the patient on what to expect following surgery, and protect the joint.

<table>
<thead>
<tr>
<th>Timeline</th>
<th>Milestones</th>
<th>Treatment Recommendations</th>
</tr>
</thead>
</table>
| **Week 1** (Day 0-7) | • AROM/PROM = 0-90°  
  o Recommend not emphasizing hyperextension equal to contralateral side, as patient should achieve this over time  
  • Active quadriceps contraction with superior patellar glide | • Wall slides  
  • Patellar mobilization  
  • Gait training  
  • Stationary bike for ROM  
  Home Program  
  • Self applied ROM  
  • Self patellar mobilizations  
  • Quad sets  
  • Long arc quads (90-30° flexion)  
  • SLR [may use electrical stimulation to assist with quad activation]³³ |
| **Week 2** (Day 7-14) | • Flexion >110°  
  • Gait without crutches  
  • Use of bike without difficulty  
  • Walking with full extension  
  • Reciprocal stair climbing (with hand rail use)  
  • Maintain knee extension of 0°  
  • Double limb sit to stand from 17” seat | • Step ups in pain free ROM  
  • Scar mobilizations when skin is healed  
  • Wall squats/sits  
  • Prone hangs or bag hangs for full extension ROM (if not already achieved)  
  • Patellar mobilizations in flexion (if flexion ROM limited) |
| **Weeks 3-5** (Day 14-35) | • Flexion to within 10° of contralateral  
  • Reciprocal stair climbing (without hand rail use)  
  • Quad strength 4+/5 or greater (test @ 45° flexion)  
  • Maintain knee extension of 0°  
  • Within one SD of 5x Sit to Stand test norm for age group⁷ | • Patellar &/or Tibiofemoral mobilizations (as appropriate)  
  • Progress bike and stair master duration to 10-minute minimum  
  • Begin balance and proprioception |
## ACLR Rehabilitation

### Weeks 6-8
(Day 35-56)
- Normalized gait pattern
- Full ROM compared to contralateral (recommend not emphasizing hyperextension)
- No greater than 1+ effusion using the Stroke test\(^\text{35}\)
- 5x Sit to stand: normal values for age group\(^7\)
- \(\leq 2\) errors on SL squat\(^3,15\)
- Progressive resistive exercises
- Begin running progression on treadmill (progression based on the Soreness Rules)\(^{10}\)

### Weeks 9-12
(Day 56-84)
- Hop tests >85%
- Maintain ROM
- Trace to Zero effusion grade using the stroke test
- \(\leq 1\) errors on SL squat (week 10)\(^3,15\)
- Zero errors on SL squat (week 12)\(^3,15\)
- Sport specific exercises
- Agility activities
- Functional testing
- Closed chain core strengthening
- Running progression

### Weeks 13-Return to Sport
- All hop tests symmetry >90%\(^{11}\)
- Modified Star Excursion Balance Test symmetry \(\leq 4\)cm\(^{14}\)
- Acute to chronic workload ratio < 1.5\(^{13,16,17}\)
- Sport specific exercises
- Agility activities
- Functional testing
- Closed chain core strengthening
- Running progression

### Follow up functional testing
- 4, 5, 6, and 12-month post-op testing
- Progression towards power activities as needed
- Maintain gains in strength
- Hop tests (90-100% of contralateral)
- Maintain ROM

## Precautions/Additional information

**Graft protection:**
- Brace use and graft type are at the discretion of the surgeon.
- Stress to ACL with passive ROM 0-120° is minimal. Most strain occurs in last 30° of NWB extension\(^2,5,9,15\).

**Adjunct treatments:**
- NMES may be instrumental in improving muscular performance for those not responding to traditional strengthening\(^3\).
- If concomitant injury present at the same time, that injury dictates rehab progression:
  - Meniscal injury with repair:
    - Full PROM is allowed. Ambulate WBAT with brace locked at 0° until week 5
    - No loaded knee flexion beyond 45° until week 5, none beyond 90° until week 8
    - No forced knee hyperextension if anterior horn repair /No forced knee flexion if posterior horn repair
    - Avoid OKC exercise from 0-30° and CKC exercise from 90-120° if patient shows signs/symptoms of patellofemoral irritation\(^4,5\)
  - Chondral damage: restrict WB for 3-4 weeks to avoid stressing the healing cartilage. Beware that prolonged weight bearing restriction may result in difficulty recovering ROM and quad activation\(^4\).
  - Partial meniscectomy: no modification of guideline (symptom management)\(^12\).
ACLR Rehabilitation

- MCL: If surgical repair, avoid directly stressing the MCL, and consider sagittal plane limitations if needed\textsuperscript{24,31}.
- PCL: follow PCL guidelines

Treatment Progression/Success:

- Factors that can impact rehabilitation success include the following: psychosocial issues, motivation, swelling, quad activation failure, acute reconstruction\textsuperscript{21}, involvement of other structures\textsuperscript{22}.
- Success measured by: 1. Less than mild effusion, 2. >90% hamstring and 3. quad strength, 4. Absence of giving way episodes, 5. Participation in 1-2 seasons of sports at previous activity level, 6. Patient reported outcomes\textsuperscript{20}.
- Patient Reported Outcome Measure: Consider using SANE score, as it correlates well with Cincinnati Knee Rating System\textsuperscript{29}.
- Consider using Stoke Test Grading for Effusion to determine whether to progress\textsuperscript{35}. Use this tool to assist with grading activity. \textit{i.e.} - increased effusion by 2 grades would lead to a decrease in activity until the effusion decreases to the previous level.
- Weight bearing exercises alone are not enough for optimal outcomes. Graded increases in load, appropriate to the phase of healing, should be considered. \textsuperscript{33}

<table>
<thead>
<tr>
<th>For questions regarding the patient’s medical care, new orders, or insurance questions:</th>
<th>For additional questions, comments, or concerns regarding the implementation of these physical therapy guidelines, please contact</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dr. Kaar's patients</strong> should contact Duncan at 314-577-8525 or <a href="mailto:duncan.mchardy@health.slu.edu">duncan.mchardy@health.slu.edu</a>.</td>
<td>Chris Sebelski, PT, DPT, PhD, OCS, Director of the SLU – SSM Health Physical Therapy Residency 314 977 8724 OR <a href="mailto:chris.sebelski@health.slu.edu">chris.sebelski@health.slu.edu</a>.</td>
</tr>
<tr>
<td><strong>Dr. Kim's patients</strong> should contact Julia (clinical nurse specialist) at 314-577-8524 or <a href="mailto:julia.santiago@health.slu.edu">julia.santiago@health.slu.edu</a>.</td>
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</tr>
</tbody>
</table>

Please respond to our anonymous survey regarding these guidelines to assist in improving patient care and advocacy.

[https://slu.az1.qualtrics.com/jfe/form/SV_bpX7Z9AaVTzGbJ](https://slu.az1.qualtrics.com/jfe/form/SV_bpX7Z9AaVTzGbJ)

### Appendices of referenced assessments

<table>
<thead>
<tr>
<th>Soreness Rules Adapted from Fees et al. 1998\textsuperscript{10}</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Criterion</strong></td>
</tr>
<tr>
<td>1. Soreness during warm-up that continues</td>
</tr>
<tr>
<td>2. Soreness during warm-up that goes away</td>
</tr>
<tr>
<td>3. Soreness during warm-up that goes away from redevelops during session</td>
</tr>
<tr>
<td>4. Soreness the day after lifting (not muscle soreness)</td>
</tr>
<tr>
<td>5. No soreness</td>
</tr>
</tbody>
</table>
ACLNR Rehabilitation

- 5xSTS Normative Values

<table>
<thead>
<tr>
<th>Age (n)</th>
<th>Mean ± SD (95%CI)</th>
<th>Min-Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>14–19 (25)</td>
<td>6.5 ± 1.2 (6.0–7.0)</td>
<td>4.7–9.7</td>
</tr>
<tr>
<td>20–29 (36)</td>
<td>6.0 ± 1.4 (5.6–6.5)</td>
<td>3.9–11.2</td>
</tr>
<tr>
<td>30–39 (22)</td>
<td>6.1 ± 1.4 (5.5–6.8)</td>
<td>4.1–10.4</td>
</tr>
<tr>
<td>40–49 (15)</td>
<td>7.6 ± 1.8 (6.6–8.6)</td>
<td>5.6–13.2</td>
</tr>
<tr>
<td>50–59 (20)</td>
<td>7.7 ± 2.6 (6.5–8.9)</td>
<td>4.2–12.1</td>
</tr>
<tr>
<td>60–69 (25)</td>
<td>7.8 ± 2.4 (6.8–8.7)</td>
<td>4.7–15.1</td>
</tr>
<tr>
<td>70–79 (24)</td>
<td>9.3 ± 2.1 (8.4–10.1)</td>
<td>5.5–13.3</td>
</tr>
<tr>
<td>80–85 (14)</td>
<td>10.8 ± 2.6 (9.3–12.3)</td>
<td>5.8–17.6</td>
</tr>
</tbody>
</table>

**Errors (Impairments) seen in Single Leg Squat Movement** Adapted from (Liebenson 2002) in (Bailey et al 2010)

<table>
<thead>
<tr>
<th>Midfoot collapse</th>
<th>Early heel rise</th>
<th>Poor control of knee with ascent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femoral adduction, IR</td>
<td>Pelvic drop</td>
<td>Excessive trunk flexion or knee extension on ascent</td>
</tr>
</tbody>
</table>

**Running Program**: 1

<table>
<thead>
<tr>
<th>Level</th>
<th>Treadmill</th>
<th>Track</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.1-mile walk/0.1-mile jog, repeat 10 times</td>
<td>Jog straights/walk curves (2 miles)</td>
</tr>
<tr>
<td>2</td>
<td>Alternate 0.1-mile walk/0.2-mile jog (2 miles)</td>
<td>Jog straights/jog 1 curve every other lap (2 miles)</td>
</tr>
<tr>
<td>3</td>
<td>Alternate 0.1-mi walk/0.3-mi jog (2 miles)</td>
<td>Jog straights/jog 1 curve every lap (2 miles)</td>
</tr>
<tr>
<td>4</td>
<td>Alternate 0.1-mi walk/0.4-mi jog (2 miles)</td>
<td>Jog 1.75 laps/walk curve (2 miles)</td>
</tr>
<tr>
<td>5</td>
<td>Jog full 2 miles</td>
<td>Jog all laps (2 miles)</td>
</tr>
<tr>
<td>6</td>
<td>Increase workout to 2.5 miles</td>
<td>Increase workout to 2.5 miles</td>
</tr>
<tr>
<td>7</td>
<td>Increase workout to 3 miles</td>
<td>Increase workout to 3 miles</td>
</tr>
<tr>
<td>8</td>
<td>Alternate between running/jogging every 0.25 miles</td>
<td>Increase speed on straights/jog curves</td>
</tr>
</tbody>
</table>

- Hop tests: 1

Return to sport dosing should consider Acute-to-chronic workload

Each session calculated by multiplying RPE (0-10) by duration (minutes) to obtain workload (augmented units). For example, RPE of 6 x 60 minutes = workload of 360 AUs.

Acute workload = average workload over the course of 1 week

Chronic workload = average workload over course of 4 weeks

*Updated 2017-10-03*
for defining 'successful outcome' after ACL injury and
American Academy of Orthopaed compartment gonarthrosis [a
joint loading with unloader brace wear in patient with medial
prospective cohort study in elite rugby league players. Br J
injury than between
and the acute:chronic workload ratio are more predictive of
Hulin BT, Gabbett TJ, Blanch P, et al. Spikes in acute workload
Fitzgerald GK, Lephart SM, Hwang JH, Wainner RS. Hop tests
extension. A comparison of an open and a closed kinetic
Bohannon RW. Knee extension strength and body weight
determine sit-to-stand independence after stroke.
Bohannon RW, Bubela DL, Magasi SR, Wang YC, Gershon RC.
Sit-to-stand test: Performance and determinants across the
age-span. Isokinetics and exercise science. 2010; 18(4):235-
Chen FS, Rokito AS, Pitman MI. Acute and chronic
posteroalateral rotatory instability of the knee. J Am Acad
Chester R, Smith TD, Sweating D, Dixon J, Wood S, Song F.
The relative timing of VMO and VL in the aetiology of anterior
knee pain: a systematic review and meta-analysis. BMC
Fees M, Decker T, Snyder-Mackler L, Axe MJ. Upper extremity
weight-training modifications for the injured athlete. A
Fitzgerald GK, Lephart SM, Hwang JH, Wanner RS. Hop tests
as predictors of dynamic knee stability. J Orthopaedic Phys
Fitzgibbons RE, Shelbourne KD. "Aggressive" non treatment of
lateral meniscal tears seen during anterior cruciate ligament
Gabbett TJ, Kennelly S, Sheehan J, et al. If overuse injury is a
"training load error", should undertraining be viewed the same
reach symmetry at three months is related to single leg
functional performance at time of return to sports following
Ther. 2015;10(5):602-611.
Henning CE, Lynch MA, Glick KR. An in vivo strain gage study of
Hulin BT, Gabbett TJ, Blanch P, et al. Spikes in acute workload
are associated with increased injury risk in elite cricket fast
Hulin BT, Gabbett TJ, Caputi P, et al. Low chronic workload
and the acute:chronic workload ratio are more predictive of
injury than between-match recovery time: a two-season
prospective cohort study in elite rugby league players. Br J
Liebenson C. Functional exercises. J Bodywork and Movem
Ther. 2002;6(2):108-13
Lindenfeld TN, Hewett TE, Andriacchi TP. Decrease in knee
joint loading with unloader brace wear in patient with medial
compartment gonarthrosis [abstract]. Proc Annual Meeting
for defining ‘successful outcome’ after ACL injury and
reconstruction: a Delaware-Oslo ACL cohort investigation. Br J
Majors RA, Woodfin B. Achieving full range of motion after
Meszler D, Manal TJ, Snyder-Mackler L. Disorders of the			
Millet P, Pennock AT, Sterett WI, Steadman JR. Early ACL
Noyes FR, Barber-westin SD. The treatment of acute
combined ruptures of the anterior cruciate and medial
Palmiter RA, An KN, Scott SG, Chao EY. Kinetic chain exercise
Parker MG. Biomechanical and histological concepts in the
rehabilitation of patients with anterior cruciate ligament
Reinold MM, Wilk KE, Macrina LC, Dugas JR, Cain EL. Current
concepts in the rehabilitation following arthritic cartilage
2006;36(10):774-94.
Rubinstein RA, Shelbourne KD, Vannmeter CD, Mccarroll JR,
Rettig AC, Gloyesке RL. Effect on knee stability if full
hyperextension is restored immediately after autogenous
bone-patellar tendon-bone anterior cruciate ligament
Basmajian Student Award Paper: Movement patterns after
anterior cruciate ligament injury: a comparison of patients
who compensate well for the injury and those who require
1998;8(6):349-62. 1
Sailors ME, Keskula DR, Perrin DH. Effect of running on
anterior knee laxity in collegiate-level female athletes after
Schierf M, Petermann J, Trus P, Baumgärtel F, Gotzen L.
Anterior cruciate and medial collateral ligament injury. ACL
reconstruction and functional treatment of the MCL. Knee
Shelbourne K., Barnes, A., & Gray, T. (2012). Correlation of a
Single Assessment Numeric Evaluation (SANE) Rating With
Modified Cincinnati Knee Rating System and AOK Subjective
Total Scores for Patients After ACL Reconstruction or Knee
Arthroscopy. The American Journal Of Sports Medicine,
40(11), 2487-2491.
Snyder-mackler L, Delitto A, Stralka SW, Bailey SL. Use of
electrical stimulation to enhance recovery of quadriceps
femoris muscle force production in patients following
1994;74(10):901-7
Snyder-mackler L, Delitto A, Bailey SL, Stralka SW. Strength of
the quadriceps femoris muscle and functional recovery after
reconstruction of the anterior cruciate ligament. A
prospective, randomized clinical trial of electrical stimulation.
Interrater Reliability of a Clinical Scale to Assess Knee Joint
Effusion. Journal of Orthopaedic & Sports Physical Therapy,
39(12), 845-849.
Wilk KE. Rehabilitation of isolated and combined posterior

Updated 2017-10-03