

What factors must be considered in 'return to school' following concussion and what strategies or accommodations should be followed?

A systematic review

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ABSTRACT

Objective To evaluate the evidence regarding (1) factors affecting return to school (RTS) and (2) strategies/accommodations for RTS following a sport-related concussion (SRC) in children and adolescents.

Design A systematic review of original studies specifically addressing RTS following concussion in the paediatric and sporting context.

Data sources MEDLINE (Ovid), Embase (Ovid), PsycInfo (Ovid) electronic databases and the grey literature OpenGrey, ClinicalTrials.gov and Google Advanced.

Eligibility criteria Studies were included if they were original research on RTS following SRC in children aged 5–18 years published in English between 1985 and 2017.

Results A total of 180 articles were identified; 17 articles met inclusion criteria. Several factors should be considered for RTS after concussion, including: symptomatology; rest following injury; age/grade; and course load. On RTS after concussion, 17%–73% of students were provided academic accommodations or experienced difficulty with RTS. Students were more likely to obtain academic accommodations in schools with a concussion policy if they had a medical RTS letter and had regular medical follow-up after concussion.

Conclusions Schools should have a concussion policy and offer individualised academic accommodations to students recovering from SRC on RTS; a medical letter should be provided to facilitate provision/receipt of academic accommodations; students should have early, regular medical follow-up following SRC to help with RTS and monitor recovery; students may require temporary absence from school after SRC; clinicians should assess risk factors/modifiers that may prolong recovery and require more intensive academic accommodations.

PROSPERO registration number CRD42016039184.

INTRODUCTION

Concussions are common in sports, particularly in children and adolescents, with about 70% of sport-related head injuries occurring in persons under 18 years of age.¹ About 100 000–175 000 children present annually to US emergency departments (ED) with sport-related concussion (SRC), which accounts for 25%–50% of paediatric concussions.^{2–5} Concussions represent 9%–12% of sport injuries in high school athletics.^{6,7}

Children face different issues than adults after SRC, with RTS being a key aspect of management. For children and adolescents who recover quickly from SRC, school return may require minimal

support. However, postconcussion cognitive symptoms such as impaired memory, attention and concentration, and somatic symptoms such as headaches, dizziness and fatigue may negatively impact students' ability to RTS.^{8–10} Students with more numerous/severe symptoms may have symptom exacerbation with RTS.¹¹

Several consensus/position statements and guidelines have addressed RTS after concussion.^{12–16} Following the Fourth International Consensus Conference on Concussion in Sport, the Child-SCAT3 assessment tool was developed for children aged 5–12 years, with a child-specific symptom scale and recommendations for RTS. The Concussion in Sport Consensus Statement also addressed children's cognitive requirements and need for school accommodations.¹⁷ However, these resources have been based on limited empirical research. Many areas of RTS lack evidence-based guidelines.

Therefore, this systematic review addressed two questions:

1. What factors must be considered in 'return to school' following concussion?
2. What strategies or accommodations should be recommended in 'return to school' following concussion?

METHODS

This systematic review was conducted as part of a larger review on differences in concussion management between children and adults, which was presented at the Fifth International Consensus Conference on Concussion in Sport.^{18–20} However, it represents a more detailed analysis of RTS in children and adolescents following SRC.

This systematic review was prospectively registered in the PROSPERO database (registration number CRD42016039184).

Literature identification

The search strategy (box 1) was developed in collaboration with a specialist librarian. Electronic databases searched were Ovid MEDLINE, Ovid Embase and Ovid PsycInfo, in addition to reviewing reference lists of retrieved articles and published articles by the authors to identify any potentially eligible articles not identified by the electronic database search. Three grey literature repositories (OpenGrey, ClinicalTrials.gov and Google Advanced) were searched. The searches addressing both



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Box 1 Search strategy

Ovid MEDLINE:

1. exp Brain Concussion/
2. concuss\$.tw.
3. ((mild or minor or minimal) adj (traumatic brain or tbi)).tw.
4. mtbi.tw
5. exp Brain Injury/
6. (((severe or moderate) adj2 (head or brain or traumatic or tbi)) not (mild or minor)).ti.
7. 5 not 6
8. or/1–4,7
9. 8 and (child* or adolescen*).mp.
10. 9 not (animal/not human/)
11. limit 10 to English
12. limit 11 to yr="1985-Current"
13. (return* adj3 (school or learn*)).mp.
14. 12 and 13

Ovid Embase:

1. Brain Concussion/or Concussion/
2. concuss\$.tw.
3. ((mild or minor or minimal) adj (traumatic brain or tbi)).tw.
4. mtbi.tw
5. exp Brain Injury/
6. (((severe or moderate) adj2 (head or brain or traumatic or tbi)) not (mild or minor)).ti.
7. 5 not 6
8. or/1–4,7
9. 8 and (child* or adolescen*).mp.
10. 9 NOT ((exp animal/or nonhuman/NOT exp human)
11. limit 10 to English
12. limit 11 to yr="1985-Current"
13. (return* adj3 (school or learn*)).mp.
14. 12 and 13

Ovid PsycInfo:

1. exp Brain Concussion/
2. concuss\$.tw.
3. ((mild or minor or minimal) adj (traumatic brain or tbi)).tw.
4. mtbi.tw
5. exp Head Injuries/OR exp Traumatic Brain Injury/
6. (((severe or moderate) adj2 (head or brain or traumatic or tbi)) not (mild or minor)).ti.
7. 5 not 6
8. or/1–4,7
9. limit 8 to (childhood or adolescence <13 to 17 years>)
10. (minors or minors* or boy or boys or boyfriend or boyhood or girl* or kid or kids or child or child* or children* or schoolchild* or schoolchild).mp. or school child.ti,ab. or school child*.ti,ab. or (adolescen* or juvenil* or youth* or teen* or under*age* or pubescen*).mp. or exp pediatrics/ (pediatric* or paediatric* or peadiatric*).mp. or school.ti,ab. or school*.ti,ab.
11. 8 and 10
12. 9 or 11
13. limit 12 to English
14. limit 13 to yr="1985-Current"
15. (return* adj3 (school or learn*)).mp.
16. 14 and 15

questions (factors and accommodations) were run concurrently; however, the results were analysed separately.

Article selection

Inclusion criteria were:

- ▶ original research on RTS following SRC
- ▶ in children aged 5 years to less than 18 years
- ▶ published in English
- ▶ between 1985 and May 2016 (results presented at the Berlin meeting).

The search was repeated for this updated review to include studies published between the initial search and June 2017.

Exclusion criteria were:

- ▶ studies of moderate/severe traumatic brain injuries
- ▶ patients with no clear history of head trauma or SRC
- ▶ patients who sustained non-accidental injury
- ▶ preschool-age children.

Studies evaluating patients with mixed mechanisms of injury were included if SRC was part of the study population. As well, studies with mixed age cohorts were included if there were sufficient numbers of children/adolescents less than 18 years of age. In addition, studies examining cognitive activity/rest or cognitive impairment following SRC were included as a proxy for school effects following concussion.

All titles and abstracts identified by the search were reviewed independently by two of the authors (LKP and GAD) and the full texts of all potentially eligible articles were obtained and reviewed. The final selection of articles was determined by consensus among the authors.

Data extraction

The following data from the included studies were inputted into a data extraction table independently by LKP and GAD: study design; participant characteristics; exposure/intervention; outcome; results; limitations.

Risk of bias assessment

Two authors (LKP and GAD) independently assessed the quality of each study using the Downs and Black (DB) checklist.²¹ This tool can be used for randomised and non-randomised study designs. Discrepancies in DB scoring were resolved by consensus. The level of evidence for each study was assessed independently by each of the authors using The Oxford 2011 Levels of Evidence.²² All authors agreed on the assessed levels of evidence.

RESULTS

Seventeen studies were included (figure 1).^{23–39} The initial search generated 167 potentially eligible articles of which 11 met inclusion criteria.^{25–27 29 30 34–37} Two additional studies were independently identified by one of the authors (GAG).^{38 39} The updated search identified 10 additional potential articles, of which three^{28 32 33} met inclusion criteria, and an additional article was identified by one of the authors (GAG).³¹ Many of the included studies evaluated mixed cohorts of children, adolescents and adults, as well as varied mechanisms of injury not related to sport. Frequent areas of limitations for the included studies included: lack of reported adverse events; external validity for most studies as the populations studied were recruited from urban EDs or specialty concussion clinics; lack of blinding and randomisation. In addition, the overall level of evidence was low (3 or 4); there were only two randomised controlled trials (RCT) identified.^{36 38}

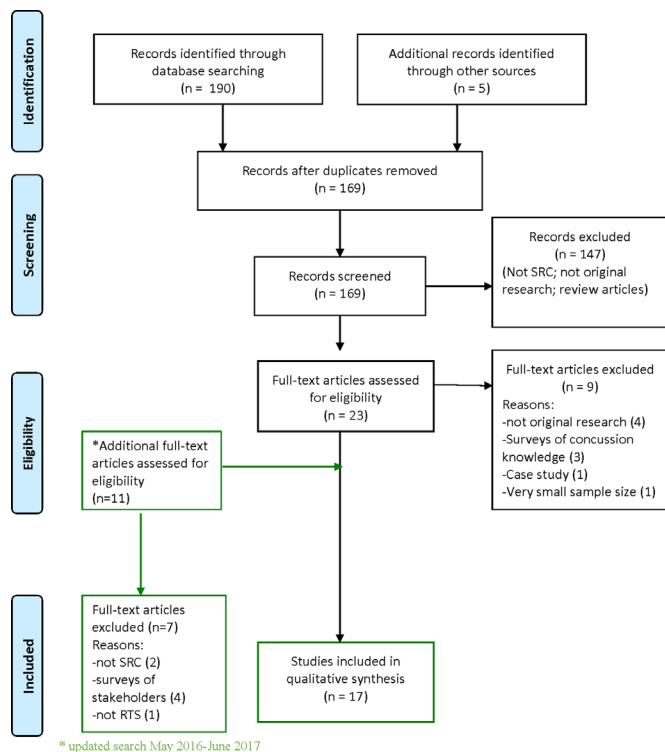


Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram. RTS, return to school; SRC, sport-related concussion.

Factors to be considered on RTS following concussion

Eleven articles examined factors to be considered after concussion on RTS (table 1).^{23–33} These factors include:

1. Symptom load/severity: Higher symptom loads and more severe symptoms were associated with a greater likelihood of missing more days of school and having difficulties on RTS, in addition to longer recovery.^{23 25 29–31}
2. Types of symptoms: Symptoms such as headache, visual disturbances, memory deficits, difficulty concentrating, executive dysfunction and vestibular abnormalities may adversely affect a student's ability to attend school after a concussion.^{23 25–27 29 31}
3. Duration of symptoms: Patients with longer duration of symptoms had more difficulty with RTS^{23 30}; high cognitive loads after injury were associated with persistent symptoms.²⁴
4. Age/grade or school level: Adolescents/high school students tended to have more postconcussion symptoms, greater severity of symptoms, and took longer to recover, to RTS and to return to play (RTP) than younger children.^{25 29–31} In addition, adolescents were more concerned about negative academic effects of concussion than younger children.³⁰
5. Course load: Certain subjects such as math pose greater problems for students on RTS after a concussion, followed by reading/language, arts, science and social studies.³⁰
6. Rest following injury: Patients who did not initially rest following injury took longer to RTS than those who rested immediately following injury³²; high cognitive loads/increased school attendance exacerbated symptoms.^{24 28}

Socioeconomic status (SES) may also affect concussion recovery. A US pilot study examining SES and effect on concussion recovery found that patients with private insurance missed more days of school following concussion than patients with public insurance (mean of 5.2 days \pm 10.6 vs 2.0 days \pm 2.1).³³

Additional factors to be considered include school concussion policies/resources, medical guidance to schools following concussion diagnosis and medical follow-up after concussion.^{36 37 39}

Strategies or accommodations for RTS

Six articles examined strategies or provision/receipt of accommodations for RTS (table 2).^{34–39} Other than temporary school absence, the types of academic accommodations provided were not specified. Most students were able to RTS after 2–5 days,^{29 37 38} although up to 45% of students may experience exacerbation/recurrence of symptoms on RTS.³⁴ On RTS after concussion, 17%–73% of students were provided academic accommodations and/or experienced school difficulty.^{23 25 26 29 35 37 39} An RCT found that academic accommodations were more likely to be initiated for students recovering from concussion in schools with concussion policies.³⁶ Concussed students who received outpatient medical follow-up, parental education and a medical RTS letter after initial assessment in an ED were also more likely to receive academic accommodations on RTS.^{37 39} Some academic subjects, such as mathematics and reading/language, may pose greater problems for students on RTS following a concussion, suggesting that these subjects might require more intervention.³⁰

DISCUSSION

Factors to be considered on RTS following concussion

Although historically concussion management has focused on return to sport, RTS is more important in children and adolescents, since school is their primary 'work'.⁴⁰ Four factors should be considered on RTS after concussion^{23–33 36 37 39}:

1. symptomatology
2. age/school level
3. course load
4. rest following injury.

Students with more symptoms, greater symptom severity, more persistent symptoms and particular symptoms such as difficulty concentrating, executive dysfunction, visual deficits and vestibular abnormalities took longer to recover and had more difficulty with RTS.^{23 25 26 29–31 35} Visual abnormalities and vestibulo-ocular abnormalities are particularly common after concussion and in patients with persistent symptoms.^{41–45}

Adolescents/high school students tended to have more symptoms, more severe symptoms and more difficulty with RTS than younger students, and took longer to recover.^{29 30 34 39} Age 13 years old and greater was a predictor of persistent concussion symptoms in a recent prospective, multicentre ED cohort study.⁴⁶ The reasons for age and school level differences are unclear but may reflect the nature of injury manifestation in adolescents; increased academic and social demands; greater challenges to implement consistent, coordinated management strategies across multiple classes/teachers; and greater independence and decreased supervision in compliance with medical recommendations. These studies, however, sampled children and adolescents from specialty clinics, which may represent an overall higher symptom burden and severity, and therefore may limit the generalisation of their findings.

Lack of rest, both cognitive and physical, immediately following concussion has also been associated with persistent symptoms. Higher cognitive activity, such as school attendance, may cause exacerbation of symptoms and prolonged recovery from concussion, as well as longer RTS.^{11 24 28 32} Student-athletes who continued to play after injury took twice as long to recover and were almost nine times as likely to have prolonged recovery

Table 1 Articles examining factors to be considered on return to school following a concussion

Article	Study design, duration, country	Participants (n, age, sex)	Exposure/intervention (Definition)	Outcome (Definition)	Results (including statistical outcomes)	Main limitations	Study quality assessment (DB score)	Level of evidence
Baker <i>et al</i> ²³	Retrospective, descriptive study (telephone interview of cohort) 2010–2012 USA	Student athletes (n=91), aged 13–19 years	SRC observed by athletic trainer and assessed by sports medicine physician/telephone follow-up/SCAT2, BCTT and ANAM or ImpACT	Factors associated with school difficulties following concussion and school days missed	<ul style="list-style-type: none"> ▲ Problems with RTS=35/91 (38.5%) ▲ Age, gender, previous concussions not associated with school problems ▲ Days to recover: >10=57%, >21=29% ▲ Recovery <10 days=less likely to report school problems (P<0.01) ▲ Students who reported school problems: (A) longer to become asymptomatic (P<0.005) or pass BCTT (P<0.03), (B) more symptoms (P<0.021), (C) higher severity scores (P<0.023), (D) blurred vision (2.5 times), (E) difficulty remembering (1.8 times), (F) ANAM/ImpACT BS=49% vs no BS=26% (P<0.03) ▲ Missed days of school: higher symptom severity scores (P<0.032) 	<ul style="list-style-type: none"> ▲ Significant delay for phone follow-up (mean of 14.4±9.6 months); recall bias ▲ Two different CNTs used ▲ 31/91 (34%) of patients asymptomatic at time of first clinic appointment 	17	4
Brown <i>et al</i> ²⁴	Single-centre, prospective cohort October 2009 to July 2011 USA	n=335 Mean age 15 (8–23) years 62% male	Patients seen at a sports concussion clinic ≤3 weeks after concussion. PCSS and cognitive activity scale	Effect of cognitive load on duration of PCS	<ul style="list-style-type: none"> ▲ Mean PCSS score at initial visit was 30 ▲ Mean duration of symptoms 43 days; no difference between age groups ▲ Total symptom burden at initial visit and cognitive activity independently associated with duration of symptoms ▲ Highest cognitive activity associated with prolonged symptom duration; no difference between mild/moderate cognitive activity and cognitive rest 	<ul style="list-style-type: none"> ▲ Included non-SRC ▲ Cognitive activity scale not validated ▲ Included adults ▲ Specialty sport medicine clinic ▲ No direct evaluation of RTS 	18	3
Conwin <i>et al</i> ²⁵	Retrospective EMR review July 2010 to December 2011 USA	n=247 (Note: same data set as ref. ³⁰) Aged 7–18 years 58% male	Patients with concussion seen at a tertiary paediatric hospital-affiliated Sports Medicine Clinic Vestibular deficit=abnormalities on VOR and/or tandem gait	Prevalence and recovery of patients with concussion and vestibular deficits, and correlate with ImpACT results	<ul style="list-style-type: none"> ▲ 81% had vestibular abnormality on initial exam; took significantly longer to RTS (59 vs 6 days, P=0.001) and be fully cleared (106 vs 29 days, P=0.001); scored more poorly on ImpACT and took longer to recover from deficits ▲ History ≥3 concussions had 100% prevalence of vestibular deficits and took longer to resolve 	<ul style="list-style-type: none"> ▲ Relatively small sample size ▲ External validity: referral of more severe concussions ▲ Delayed presentation ▲ Retrospective review ▲ 23% non non-SRC 	18	4

Continued

Table 1 Continued

Article	Study design, duration, country	Participants (n, age, sex)	Exposure/intervention (Definition)	Outcome (Definition)	Results (including statistical outcomes)	Main limitations	Study quality assessment (DB score)	Level of evidence
Darling <i>et al</i> ²⁶	Retrospective chart review and telephone follow-up 2010–2012 USA	Athletes (n=117) Aged 13–19 years (75% male) for chart review Patients and parents (n=91) (77.8%) for telephone follow-up 76.9% male	<ul style="list-style-type: none"> Patients with SRC seen at a university sports medicine clinic Once asymptomatic (SCAT2), then CNT (ANAM or ImPACT), then BCTT, then Zurich Guidelines for RTP 	Evaluate success of RTP and RTL	<ul style="list-style-type: none"> All athletes RTP without exacerbation of symptoms Telephone follow-up indicated that 42.9% had difficulty readjusting to the classroom following concussion, with 38.5% reporting new or increased issues on RTL Most common complaint was difficulty concentrating 48% had one or more CNTs below average when asymptomatic Performance on CNT was not predictive of RTL issues 	<ul style="list-style-type: none"> 2 different CNTs Last CNT prior to RTP used on average 3 weeks after injury—school problems could have already resolved Heterogeneous time of initial evaluation (some day of injury, some not for weeks after injury) University sports medicine clinic 2-month period following RTP for phone follow-up: recall bias Did not describe issues encountered on RTL or length of issues No baseline data 	17	4
Lovell <i>et al</i> ²⁷	Case-control Baseline data collected prior to 2000 and 2001 seasons USA	Concussed high school athletes (n=64) 94% male 24 controls (67% male)	mPACT before and after SRC (36 hours, days 4, 7) compared with non-injured controls	Evaluate memory dysfunction and self-reporting of symptoms in high school athletes with concussion	<ul style="list-style-type: none"> Significant decline in memory in concussed athletes compared with controls Significant differences between preseason and postinjury memory test results at day 4 and day 7 after injury Self-reported symptoms resolved by day 4 Duration of on-field mental status changes was related to memory impairment at 36 hours, days 4 and 7 after injury; also related to slower resolution of self-reported symptoms 	<ul style="list-style-type: none"> Study and control groups not equivalent in number, gender or sport Excluded those with LOC Small sample size Very short study duration (up to 7 days after injury) Ages of athletes not specified No direct evaluation of RTS or academic needs 	15	4

Continued

Table 1 Continued

Article	Study design, duration, country	Participants (n, age, sex)	Exposure/intervention (Definition)	Outcome (Definition)	Results (including statistical outcomes)	Main limitations	Study quality assessment (DB score)	Level of evidence
Makki <i>et al</i> ²⁸	Prospective cohort study Dates not specified USA	n=42 Aged 14–19 years 88% male	Student-athletes with SRC attending concussion clinic within 10 days of injury Daily reports on symptoms (PCSS) and hours of school attendance for 14 days after first clinic attendance	Prospective evaluation of relationship of school attendance and symptoms after SRC	<ul style="list-style-type: none"> ▲ Mean age 15.4±1.3 years ▲ Mean symptom severity score on first clinic day 32.7±23.3 ▲ Symptom severity scores decreased with time ($\beta=-2.12$, $P<0.001$) ▲ Symptom severity score increased with hours of school ($\beta=0.32$, $P<0.0137$) with no significant effect of days from injury ($\beta=-2.12$, $P=0.50$) ▲ Fast, moderate or delayed recovery speed groups did not moderate relationship between school hours and symptoms ($P=0.44$) ▲ Hours of school increased with days from injury 	<ul style="list-style-type: none"> ▲ Subjects not well described ▲ No data regarding numbers of subjects in fast, moderate and delayed recovery speed groups ▲ Short period of study (only 14 days) ▲ Small sample size ▲ No power calculation ▲ Subjects seen at concussion clinic ▲ Dates of study not identified 	12	3
Purcell <i>et al</i> ²⁹	Retrospective chart review September 2009 to December 2012 Canada	n=198 Aged 8–17 years, 220 SRC 72.7% male	SRC assessed at a university sports medicine clinic	Time to symptom-free RTL and RTP; comparison of children 8–12 years with adolescents aged 13–17 years	<ul style="list-style-type: none"> ▲ Symptom-free (days) 8–12 years old=12 vs 13–17 years old=14 ($P=0.04$) ▲ RTL (days) 8–12 years old=4 vs 13–17 years old=2.5 ($P=0.86$) ▲ RTP (days) 8–12 years old=14 vs 13–17 years old=19.5 ($P=0.06$) ▲ 31.3% were aged 8–12 years ▲ Initial SCAT2 symptom scores higher in adolescents (12.3 vs 10.6 in 8–12 years old) ($P=0.07$) ▲ Symptom severity score higher in adolescents (19.0 in 8–12 years old vs 27 in 13–17 years old) ($P=0.08$) ▲ 39.5% of patients symptom-free at 10 days ▲ 16% still symptomatic 4 weeks after injury ▲ 40.3% required academic accommodations ▲ 8% of 8–12 years old RTP by 4 weeks versus 62.6% of 13–17 years old ▲ RTL within 5 days: children 60%, adolescents 71.8% 	<ul style="list-style-type: none"> ▲ Retrospective chart review ▲ SCAT2 not validated in paediatric patients ▲ External validity: patients seen at sports medicine clinic (care may not be applicable to community) 	20	4

Continued

Table 1 Continued

Article	Study design, duration, country	Participants (n, age, sex)	Exposure/intervention (Definition)	Outcome (Definition)	Results (including statistical outcomes)	Main limitations	Study quality assessment (DB score)	Level of evidence
Ransom <i>et al</i> ³⁰	Case review—structured school questionnaire Dates not specified USA	n=349 Aged 5–18 years 67% male	Concussion—symptomatic versus recovered/outpatient concussion clinic large regional medical centre, assessed within 28 days of injury Parent and child report (69%), parent-only report (31%)	Nature and severity of symptoms; extent of adverse academic effects of concussion Using PCSI, RBL, CLASS	<ul style="list-style-type: none"> ▲ Symptomatic students and parents reported higher levels of concern for impact of concussion on school performance ($P<0.05$); more school-related problems ($P<0.001$) ▲ Symptomatic high school students reported more adverse academic effects than younger students ($P<0.05$) ▲ Greater severity of PCS associated with more school-related problems and worse academic effects ($P<0.001$) ▲ Higher frequency of impaired neurocognitive scores in symptomatic group ($P<0.001$) ▲ High school students more concerned about academic effects ($P<0.01$) ▲ Math as most problematic class in all grade levels followed by reading/language, arts, science, social studies 	<ul style="list-style-type: none"> ▲ External validity: patients seen in a concussion clinic may not be representative of community ▲ Time period of study not specified ▲ Does not discuss how sample size was determined ▲ No objective data on academic effects; only parent/child reports, which may be influenced by other variables 	17	4
Ransom <i>et al</i> ³¹	Cohort study Dates not specified USA	n=142 Students aged 11–18 years 59% male	Students with concussion evaluated within 4 weeks of injury at an outpatient concussion clinic <ul style="list-style-type: none"> ▲ PCSI, CLASS, modified for perceived academic problems during MACS or IMPACT 	Demonstrate utility of EBA approach to establish predictive measures to identify students at risk for perceived academic problems during concussion recovery	<ul style="list-style-type: none"> ▲ 56% reported low number of academic problems; 44% reported high number of academic problems ▲ SRC: 87% in low group; 77% in high group ▲ High academic problems associated with greater PCS severity, executive problems and exertional response (<0.001) ▲ Cognitive measures did not predict school difficulty ▲ Self-reported symptom ratings predicted perceived academic problems more strongly in high school students compared with elementary and middle school students ($P>0.001$ vs 0.04) ▲ Parent reports did not account for additional significant variance 	<ul style="list-style-type: none"> ▲ Dates not specified ▲ Recall bias: students and parent asked to recall perceived academic problems ▲ External validity: outpatient concussion clinic ▲ No power calculation ▲ 2 different CNTs used 	16	3

Continued

Table 1 Continued

Article	Study design, duration, country	Participants (n, age, sex)	Exposure/intervention (Definition)	Outcome (Definition)	Results (including statistical outcomes)	Main limitations	Study quality assessment (DB score)	Level of evidence
Taubman <i>et al</i> ²²	Prospective observational cohort study 9 December 2011 to 4 June 2013 USA	n=103 Aged 11–19 years; 95 patients completed study 57/95 (60%) male	Patients with concussion who presented within 7 days of injury to a private paediatric practice ▲ Cognitive and physical rest ▲ PCS scale	Recovery of concussion defined as RTS without symptoms or accommodations (quick recovery=RTS in <30 days; prolonged recovery=RTS in >30 days)	<ul style="list-style-type: none"> ▲ 58/95 (61%) rested immediately after injury ▲ Patients who delayed rest were significantly more likely to have prolonged recovery versus those who rested immediately (67% vs 35%, P=0.016) ▲ SRC 62/95 (68%) ▲ In patients who had a quick recovery, RTS was significantly less in those with immediate rest compared with those with delayed rest (P=0.029) and recovered earlier than those who delayed rest (10 days vs 13 days, P=0.050) ▲ PCS score significantly higher in patients with prolonged recovery versus those with quick recovery (40 (3–70) vs 18 (0–100), P=0.002) 	<ul style="list-style-type: none"> ▲ Only 68% SRC ▲ Unclear what PCS score measured (number of symptoms or symptom severity) ▲ Not clear if all potential patients were included ▲ Determination of sample size not outlined ▲ Very strict interpretation of rest recommendation from CISG; did not recommend school absence until all symptoms resolved ▲ rather gradual increase in cognitive activities such that symptoms are not significantly exacerbated 	20	3
Zuckerman <i>et al</i> ²³	Retrospective cohort study January 2012 to May 2015 USA	n=282 Median age 15.8 years (range 11.6–22.2 years) 61.4% male	Middle school, high school and collegiate student-athletes seen at a regional comprehensive SRC centre, telephone interviews	Effect of SES on outcomes after SRC	<ul style="list-style-type: none"> ▲ Previous concussion in 34% ▲ Most concussions in football (32.3%), soccer (16.3%), basketball (15.5%) ▲ Median symptom duration 21 days (range 1–365 days) ▲ Median missed school days, 2 (range 0–90 days) ▲ Median missed days of practices, 10 (range 0–150 days) ▲ No relationship between SES and symptom duration or days of missed practice ▲ Student-athletes with private insurance missed more days of school than those with public insurance (HR 0.46, 95% CI 0.26 to 0.83, P=0.009) 	<ul style="list-style-type: none"> ▲ Mixed age cohort ▲ 58% of cohort unable to be contacted for SES info—external validity concerns ▲ Patients seen at a regional SRC centre—external validity concerns ▲ Retrospective attainment of SES status by phone interview ▲ Very skewed insurance results (90.4% private insurance) ▲ 85% white ▲ Use of zip code as measure of SES ▲ Recall bias—patients contacted a minimum of 3 months after injury, when recovered 	17	3

ANAM, Automated Neuropsychological Assessment Metrics; BCTT, Buffalo Concussion Treadmill Test; BRIEF, Behaviour Rating Inventory of Executive Function; BS, borderline score; CHEERS, Children's Exertional Effects Rating Scale; CISG, Concussion in Sport Group; CLASS, Concussion Learning Assessment and School Survey; CNT, computerised neuropsychological test; DB, Downs and Black checklist; EBA, evidence-based assessment; EEI, Exertional Effects Index; EMR, electronic medical record; IMPACT, Immediate Post-Concussion Assessment and Cognitive Test; LOC, loss of consciousness; MACS, Multimodal Assessment of Cognition and Symptoms for Children; PCS, postconcussion symptoms; PCSI, Post-Concussion Symptom Inventory; PCSS, Post-Concussion Symptom Scale; RBL, retrospective baseline; RTL, return to learn; RTP, return to play; RTS, return to school; SCAT, Sports Concussion Assessment Tool; SES, socioeconomic status; SRC, sport-related concussion; VOR, vestibular ocular reflex.

Table 2 Articles examining strategies or provision/receipt of accommodations on return to school

Article	Study design, duration, country	Participants (n, age, sex)	Exposure/intervention (Definition)	Outcome (Definition)	Results (including statistical outcomes)	Main limitations	Study quality assessment (DB score)	Level of evidence
Carson <i>et al</i> ²⁴	Retrospective EMR review April 2006 to March 2011 Canada	n=159 elementary (24.1%), secondary (55.9%), college/university (20.0%) Ages not specified 170 concussions 61.8% male	SRC student-athletes assessed by same family and sport medicine physician who gave advice regarding cognitive and physical rest after concussion	Premature RTP/RTL defined as recurrence or worsening of symptoms on RTL or RTP using SCAT and self-report	Symptom recurrence with RTP=43.5% and RTL=44.7% Prior concussion associated with more rest days before return to activity (RTA) (P<0.001) Elementary school patients required fewer rest days to RTA (1.6 days) versus high school (25.1) versus college/university (23.6) (P=0.0163)	<ul style="list-style-type: none"> Did not state reasons for going back too soon Mixed age cohort (20% college/university students) Ages not specified No definition of injury characteristics; no mention of when seen in postinjury clinic 	17	4
Conwin <i>et al</i> ²⁵	Retrospective EMR review July 2010 to December 2011 USA	Convenience sample (n=247 selected from 3740) (same data set as ref ²⁴) Median age 14 (7–18) years 58% male	Patients with concussion seen at a tertiary paediatric hospital-affiliated Sports Medicine Clinic	Identify pre-existing characteristics associated with prolonged recovery	<ul style="list-style-type: none"> RTS (median) part-time=12 days (IQR 6–21); full-time without accommodations=35 days (IQR 11–105); symptom-free 64 days (IQR 18–119); full RTP 76 days (IQR 30–153) 73% symptomatic >4 weeks; 73% prescribed school accommodations; 61% had decline in grades Pre-existing characteristics associated with prolonged recovery: depression/anxiety, dizziness at time of injury, abnormal convergence or symptom provocation on oculomotor exam, prior concussion Symptom provocation with eye exam more likely to have accommodations (P=0.0001), take longer to RTS full-time (P=0.050), be symptom-free (P=0.048), to have decline in grades (P=0.035) Patients with abnormal convergence more likely to have accommodations (P=0.038) RTS full-time compared with ages 17–18 years: 13–14 years=1.8 times, 15–16 years=1.6 times Age <12 years: almost 2× longer to be symptom-free History ≥2 concussions more than twice as long to become symptom-free (P=0.039) 	<ul style="list-style-type: none"> Relatively small sample size External validity: referral of more severe concussions Delayed presentation Retrospective review 23% non-SRC 	18	4

Continued

Table 2 Continued

Article	Study design, duration, country	Participants (n, age, sex)	Exposure/intervention (Definition)	Outcome (Definition)	Results (including statistical outcomes)	Main limitations	Study quality assessment (DB score)	Level of evidence
Giang <i>et al</i> ¹⁶	RCT August to November 2011 USA (knowledge transfer)	High schools in Oregon (n=25) (13 intervention, 12 control)	<i>Brain 101</i> website (intervention), CDC material on safety (not concussion) ▲ Pretest and post-test	Effect on parents and athletes' concussion knowledge, behavioural intention and concussion management	<ul style="list-style-type: none"> ▲ Pretest/post-test intervention group outperformed controls on sports concussion knowledge (P<0.0001) ▲ No significant difference in number of school days missed or whether accommodations provided ▲ More intervention schools implemented best practice guidelines ▲ More test schools formed a CMT (P=0.007) with a coordinator (P=0.005) ▲ More students in test schools received a variety of accommodations compared with controls (not statistically significant) 	<ul style="list-style-type: none"> ▲ Did not assess other groups (teachers, coaches, and so on). Outcome primarily RTA, not specifically RTS ▲ Lack of control for other sources of concussion knowledge 	19	2
Grubenhoff <i>et al</i> ⁷	Secondary analysis of a prospective longitudinal cohort observational study October 2010 to March 2013 USA	n=234 Aged 8–18 years enrolled, 179 completed follow-up 70% male (no PPCS) 69% male (PPCS)	Concussed patients seen in urban ED with and without prolonged symptoms (≥3 new symptoms >1 month after injury)	Number of follow-up visits after ED visit; number of school days missed; receipt of academic accommodations	<ul style="list-style-type: none"> ▲ No significant differences in demographic or injury characteristics between no PPCS and PPCS ▲ PPCS occurred in 21% ▲ Only 45% of patients had follow-up appointments after ED visit ▲ Children with PPCS missed twice as many school days (P<0.0001) but did not differ in academic accommodations ▲ Outpatient follow-up associated with receiving academic accommodations ▲ 72% missed at least 1 day of school ▲ 40% received academic accommodations; only 53% of patients with PPCS received accommodations 	<ul style="list-style-type: none"> ▲ Secondary data analysis ▲ External validity: urban ED may not represent community ▲ Urban population only ▲ Short follow-up of only 30 days ▲ Low prevalence of PPCS (21%) ▲ Did not account for reasons for school days missed ▲ 51% non-SRC 	20	4

Continued

Table 2 Continued

Article	Study design, duration, country	Participants (n, age, sex)	Exposure/intervention (Definition)	Outcome (Definition)	Results (including statistical outcomes)	Main limitations	Study quality assessment (DB score)	Level of evidence
Thomas <i>et al</i> ²⁸	Prospective RCT Urban paediatric ED May 2010 to December 2012 USA	n=99 11–22 years of age (median 13.7 years) One-third female 71% SRC	Concussed patients randomised to strict rest (intervention) versus usual care (control) ► Patients completed a diary to record physical and mental activity level, calculate energy exertion and record daily PCS	Concussion recovery and outcome	► After discharge, both groups reported a 20% decrease in energy exertion and physical activity levels ► Intervention group reported less school and after-school attendance for days 2–5 after concussion (3.8 vs 6.7 hours total, P<0.05) ► No clinically significant difference in neurocognitive or balance outcomes ► Intervention group reported more daily postconcussive symptoms (total symptom score over 10 days, 187.9 vs 131.9, P<0.03) and slower symptom resolution	► Only 71% SRC ► Included adults ► Urban ED setting may not be generalisable to community ► Strict rest group older ► Selection bias: convenience sample (patients may have been more motivated to participate) ► Diary report subject to recall bias ► Looked only at short-term outcomes (first 7–10 days) ► Did not assess long-term outcomes ► Not blinded	21	2
Zuckerbraun <i>et al</i> ²⁹	Preimplementation and postimplementation design in 2 urban paediatric EDs Pre-February to July 2009 Post-December 2009 to June 2010 USA	164 participants pre 190 participants post Mean age 10.6 years (SD 3.7) 65% male 27% SRC	Use of modified ACE tools in concussed patients	Impact of ACE-ED tools on patient follow-up and postinjury behaviour	► After implementation, 58% of patients received ACE-ED and 84% received ACE-ED DI ► Follow-up improved at all time points (32% vs 61% at week 4; P<0.001) ► After implementation, parental recall of discharge instructions significantly increased, patient's mean total PCSS was significantly higher, and report of return to normal activity was significantly longer ► Largest improvement was in recall of instructions for school restrictions ► After implementation, children reported to receive greater support than those before implementation (17% vs 4%, P<0.001) ► Two-thirds of parents reported using ACE-ED DI 'Return to School' form	► ED setting may not be generalisable to other settings ► Only 27% SRC ► Did not control for other sources of concussion knowledge ► Differences between groups may be related to time differences between each phase of the study, not just the intervention ► Possible overdiagnosis of concussion given the definition used (diagnosis could be made with only one sign/symptom) ► Possible underdiagnosis of concussion given that mechanism of injury had to be blunt force trauma to head ► Self-report bias for patient outcomes	20	3

ACE-ED, Acute Concussion Evaluation-Emergency Department; ACE-ED DI, Acute Concussion Evaluation-Emergency Department Discharge Instruction; CMT, concussion management team; CDC, Centers for Disease Control; DB, Downs and Black checklist; ED, emergency department; EMR, electronic medical record; PCS, postconcussion symptoms; PCSS, Post-Concussion Symptom Score; PPCS, persistent postconcussive symptoms; RCT, randomised controlled trial; RTA, return to activity; RTL, return to learn; RTP, return to play; RTS, return to school; SCAT, Sports Concussion Assessment Tool; SRC, sport-related concussion.

(>21 days) compared with those who were removed from play immediately after injury.⁴⁷ Although RTS was not specifically assessed, cognitive performance was lower and symptoms higher in adolescents not removed from play immediately after concussion.⁴⁷ The presence of risk factors/predictors of persistent symptoms should prompt practitioners to be more cognisant of potential difficulties in RTS and the need for more support in the RTS process.

An additional factor possibly affecting RTS after concussion is SES, though it requires more detailed study to fully understand its significance. The type of family insurance (private vs public), as a proxy for SES, may impact length of school absence following concussive injury, with concussed student-athletes with private insurance missing more days of school than those with public insurance.³³ The reasons for this difference in school attendance were not identified; however, the study population represented only about 40% of the cohort and 90% had private insurance, raising concerns about external validity and selection bias. As well, five other markers of SES were not associated with differences in recovery, which makes the significance of SES in concussion recovery unclear.

Very likely there are other factors and specific deficits after concussion, such as autonomic dysfunction, that may impact on RTS that have not yet been studied in that context.

Strategies or accommodations for RTS

Significant numbers of symptomatic students (17%–73%) may require academic accommodations on RTS after concussion^{29 35 37 39}; however, it is encouraging that a recent study found minimal long-term effects of concussion on academic performance in high school at a population level.⁴⁸ A range of strategies/accommodations to support RTS following concussion have been proposed, including temporary school absence.^{12–16 35–37 39} In the initial few days following a concussion, students may need to stay home with relative restriction of physical and cognitive activities to allow acute symptoms to improve. Exacerbation of symptoms on RTS may indicate suboptimal accommodations or students pushing through symptoms. A secondary analysis of Thomas *et al*'s study³⁸ found that symptom spikes were associated with abrupt increases in mental activity, such as school attendance and extracurricular activities, in some patients but that most students were able to RTS without symptom exacerbation.¹¹ This analysis found that symptom spikes were associated with higher symptom burdens and may be unrelated to physical or mental activity but rather other factors, such as stress or poor sleep. Conversely, some evidence indicates that longer restriction of activity, including school absence, may prolong recovery and increase symptoms.³⁸ However, the optimal length of school absence has not been determined, and is likely to vary according to type, severity and duration of symptoms. Further study of when to recommend RTS is needed to guide clinical practice.

Many review articles and consensus guidelines for RTS recommend minimising school absence to avoid possible secondary problems such as social isolation, depression and anxiety about mounting schoolwork.^{12–19 40 49–52} These guidelines also emphasise that students do not need to be symptom-free to go back to school, although this recommendation requires further validation.^{12–14 18 19 40 49–52} Current clinically derived, consensus-based recommendations suggest that as symptoms improve and students are able to tolerate about 30 min of cognitive activity at home without significant symptom exacerbation, they can try RTS with accommodations as needed. Return to cognitive activity/school may be facilitated by following a stepwise, symptom-limited programme, such as the strategy proposed in the most recent concussion consensus statement (table 3).^{16 18 19 40 53–55} Generic RTS protocols may need to be adapted to different developmental/school levels but more research is needed in this area.⁵⁶

Provision/receipt of other academic accommodations may prevent worsening of symptoms on RTS. Identification of symptom profiles and screening for specific postconcussion deficits, such as visual disturbances and vestibulo-ocular deficits, can be useful in predicting students with higher academic needs requiring symptom-targeted interventions.^{31 41 43 45} Specific academic accommodations, other than a period of school absence, were not examined in the reviewed studies but many guidelines, review articles and a survey of school nurses in Massachusetts list symptom-specific accommodations,^{12–16 40 49–54 56 57} including:

- ▶ frequent breaks
- ▶ reduced workload, modified assignments
- ▶ no tests initially
- ▶ more time to complete assignments
- ▶ preferential seating in the classroom
- ▶ reduced visual and auditory stimulation.

Strategies specific to vision-related problems include avoidance of electronic screens, frequent visual breaks, preprinted notes in large font, audiobooks and oral teaching.^{43 45}

To ensure students recovering from concussion are supported at school and receive accommodations as necessary, school personnel, parents and students need to be educated about current concussion management strategies.^{13 40 49 56 58–61} Surveys of teachers, school principals, athletic therapists, school nurses and parents have identified that concussion education, particularly of school staff and parents, is a key factor for successfully implementing an RTS protocol.^{56 59–62} An RCT demonstrated the effectiveness of a concussion policy as schools with an explicit policy were more likely to implement best practice guidelines for concussion management, and concussed students were more likely to receive academic accommodations after concussion.³⁶ A case study also found that schools who receive concussion education provide more academic accommodations to students after concussion and had more resources available.⁵⁸

Table 3 Graduated return to school strategy^{18 55}

Mental activity	Activity at each step	Goal of each step
1. Daily activities that do not give the child symptoms	Typical activities that the child does during the day as long as they do not increase symptoms (eg, reading, texting, screen time). Start with 5–15 min at a time and gradually build up	Gradual return to typical activities
2. School activities at home	Homework, reading or other cognitive activities outside of the classroom	Increase tolerance to cognitive work
3. Return to school part-time	Gradual introduction of schoolwork. May need to start with a partial school day or with increased breaks during the day	Increase academic activities
4. Return to school full-time	Gradually progress school activities until a full day can be tolerated	Return to full academic activities and catch up on missed work

Evidence-based education programmes and online educational tools can be effective to increase knowledge of concussion and management.^{36 63 64}

Development of school concussion policies can be guided by government legislation. The Ministry of Education in the province of Ontario, Canada, produced a policy memorandum mandating that all provincial school boards develop and implement a concussion policy.⁶⁵ This policy was evaluated a year after implementation in one Ontario school board by survey which found that 92% of schools have an RTP protocol and 77% of schools have an RTS protocol; however, staff training and parent education were identified as areas needing more development.⁶¹ In the USA, the National Collaborative on Childhood Brain Injury recommended five areas of policy/procedural consideration to implement appropriate infrastructure to support RTS of students with concussions, including: (1) definition and training of the interdisciplinary school team; (2) professional development of school and medical communities; (3) identification, assessment and progress monitoring protocols; (4) a flexible set of intervention strategies to accommodate students' recovery needs; and (5) systematised protocols for active communication among medical, school and family team members.⁶⁶

Furthermore, medical guidance can facilitate implementation of school supports for returning students. Providing explicit school-informed discharge instructions and an RTS letter after the initial concussion diagnosis in the ED resulted in significantly greater provision of academic accommodations than when not systematically recommended.³⁹ The sample letter provided (online supplementary appendix A) is recommended to ensure direct communication between the medical provider and the school regarding the student's concussion symptoms and needs. In addition, regular medical follow-up after concussion is crucial to monitor recovery and facilitate RTS. Healthcare providers should identify risk factors/modifiers, such as age and symptomatology, that may prolong recovery and necessitate more intensive accommodations.^{18 19} For instance, adolescents tend to be more symptomatic and more anxious about concussion, and may require more support on RTS.^{29 30 34}

Finally, recovery from concussion for students occurs in various arenas, including home, school, potential job and social/sport. Effective communication between the medical team, school personnel, student and parents/caregivers is essential to ensure successful RTS for every concussed student.^{53 56 59–62 66} Numerous surveys of various stakeholders in concussion management in students have highlighted the need for effective communication between all members of the care team.^{56 59–62} This support network can relieve anxiety about missing school, allow students to focus on recovery and facilitate symptom improvement.^{13 40 49 50 58} It is important to emphasise that full symptom resolution, resulting in full school reintegration, must precede full return to sport and participation in high-risk contact training and gameplay.^{13 14 18 19} However, early introduction of symptom-limited physical activity, supervised by a qualified health professional, is appropriate and may help facilitate RTS.¹⁸

While evidence is emerging, this review highlights the lack of research to guide RTS following SRC in children and adolescents. The studies identified had high risk of bias and study designs were mostly lower levels of evidence (3 or 4); there were only two RCTs. Many questions remain unanswered, such as the optimal length of school absence following SRC and what specific accommodations should be offered. There is an urgent need for high-quality research on SRC in children and adolescents, including RTS, to better inform management guidelines.

Limitations

RTS has been only a recent focus of concussion management and this study identified only 17 studies on this topic. The reviewed studies involved mostly high school and college students, many with mixed age cohorts (children, adolescents and adults). Despite the explosion of concussion research in the last decade, little research has been conducted in children 5–12 years of age. In addition, some studies included non-SRC and did not focus on RTS after concussion. Since we included only English language studies, these results may not be culturally generalisable and there may be language bias.

Other factors limiting generalisation of these review findings include study design, location and sample size. Level 1 evidence was not available as the majority of studies were retrospective and cross-sectional designs, with only two lower quality RCTs. Most papers had external validity and recall bias, particularly those conducted in hospital ED and specialty concussion clinics. Some studies had small sample sizes and used variable definitions of concussion and prolonged recovery. Finally, many of the studies examined school issues/outcomes at a time when there was little guidance on effective in-school management and support. With more informed guidance about RTS and provision of effective symptom-directed accommodations, RTS outcomes will likely improve.

For analysis of risk of bias, we employed the Downs and Black checklist, which was developed as a tool to be used in reviews of non-randomised studies. While we accept that the Downs and Black checklist has its limitations, and is not a perfect fit for this systematic review, it was deemed the best available for this study. An alternative risk of bias tool that would be more appropriate to the topic of RTS after paediatric concussion has yet to be developed.

RECOMMENDATIONS

- A. Schools should have a concussion policy which includes concussion education for teachers, staff, students and parents; defines individuals within the school to direct the provision of individualised student supports; and includes a mechanism to implement and monitor appropriate academic accommodations to students recovering from SRC.
- B. On diagnosis of concussion, students should be provided with a medical letter to facilitate the provision/receipt of necessary academic accommodations.
- C. Students should have early, ongoing medical follow-up following an SRC to identify symptom targets, monitor recovery and aid with RTS, with regular communication between the medical provider, family and school.
- D. Students may require temporary absence from school after concussion. Factors such as age/grade, types and severity of symptoms should be considered in determining the length of school absence. An individualised gradual RTS plan should be considered based on recovery trajectory.
- E. Clinicians should screen for specific deficits, such as visual and vestibulo-ocular disturbances, that may affect RTS and require symptom-specific academic accommodations, as well as assess risk factors/modifiers that may prolong concussion recovery, requiring more intensive academic accommodations. In particular, adolescents may require more academic support.
- F. Future high-quality research should be conducted to determine the criteria for length of absence from school, and appropriate, individualised RTS accommodations that should be provided for children and adolescents with typically recovering and prolonged SRC symptoms.

CONCLUSIONS

Students should rest physically and cognitively initially following a concussion with a gradual increase in activities as symptoms allow. RTS following SRC requires cooperation and communication between healthcare providers, school personnel, parents/caregivers and the student to ensure that individualised accommodations and support are provided to facilitate optimal recovery.

What is already known?

- ▶ The effects of sport-related concussion (SRC) in children and the recovery challenges are different from adults.
- ▶ Adolescents may take longer to recover from SRC than adults and younger children.
- ▶ Return to school should be a priority in the management of children and adolescents following SRC.

What are the new findings?

- ▶ Factors such as symptomatology, age/school level, course load and rest after injury can affect return to school following SRC.
- ▶ Schools with a concussion policy tend to offer more academic accommodations to students recovering from SRC.
- ▶ Regular medical follow-up after concussion and provision of a return to school letter can help facilitate the provision of academic support.
- ▶ Many students require a brief absence from school and academic accommodations on return to school following an SRC to avoid significant exacerbation of concussion symptoms.

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