Mobility Protocols in Enhanced Recovery Pathways after Surgery for Children with Scoliosis

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Scoliosis and Treatment

What is Scoliosis?

Human spines have natural curves in the spine which round our shoulders, our upper back out and our lower back in.

From a back view, the spine is usually straight, but some rotate and curve to the side once or more during growth (Fig. 1-2).

When this curve is more than 10°, it is diagnosed as clinical scoliosis.

Adolescent Idiopathic Scoliosis

Adolescent Idiopathic Scoliosis (AIS) is scoliosis of unknown cause affecting 1-3% of children globally. It affects 5-8 times more girls than boys, and asking to "stand up straight" doesn't correct it.[1]

Mild AIS typically does not cause pain or discomfort, but severe AIS may progress further and cause pain, a worsening self-image, and a decrease in lung function.

Surgical Treatment

Curvatures up to 40-45° are usually treated with observation, exercise, and bracing, but more severe curves may be treated with surgery. The most common surgery is Posterior Spinal Fusion (PSF), where implants are screwed in the spine bones to hold them in alignment until the vertebrae fuse (Fig. 4-5).[1]

Hospital stays for PSF are usually several days with return to activity several months.

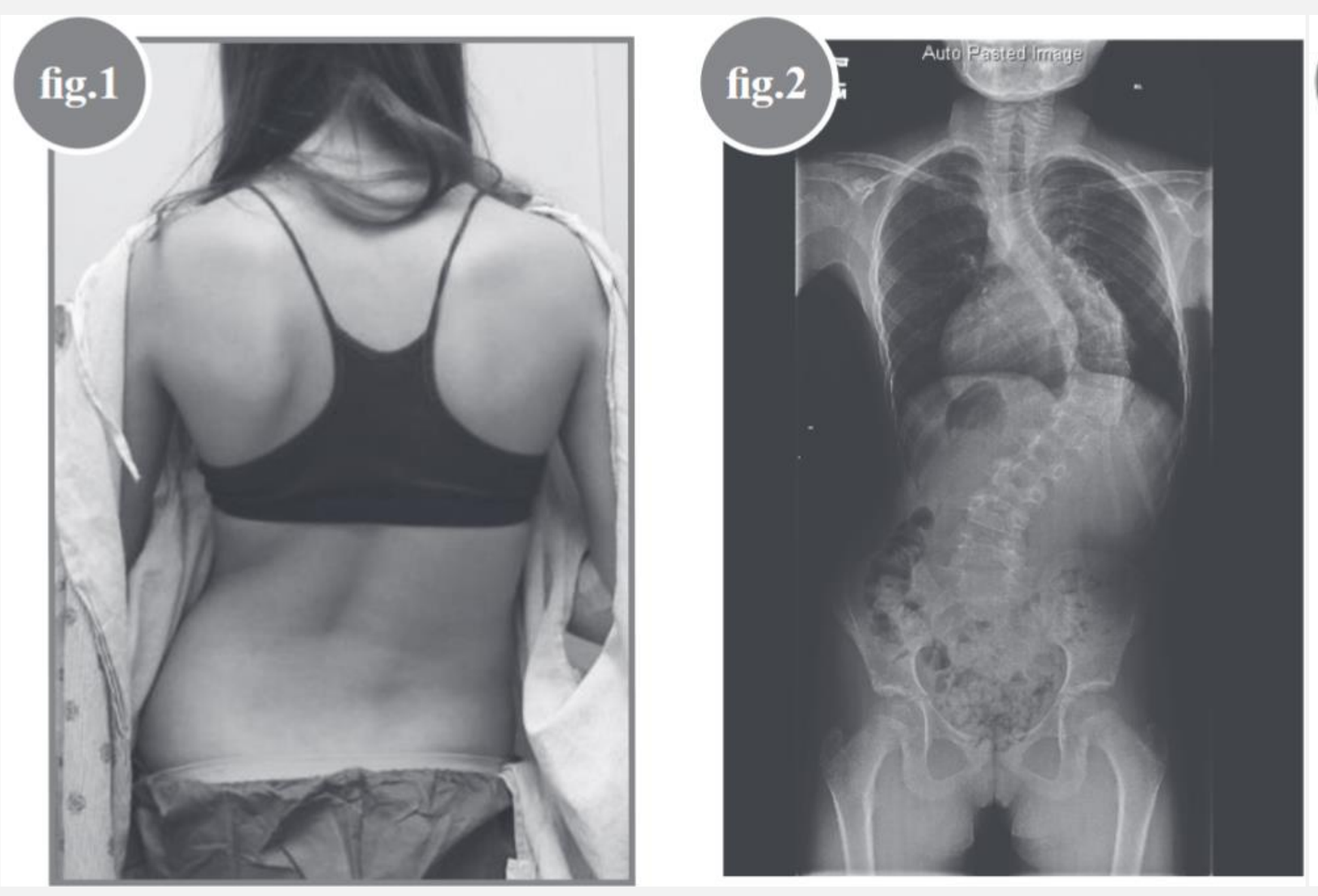


Fig. 1 & 2: clinical presentation of scoliosis – spine curved like an "S" or "C"[1]

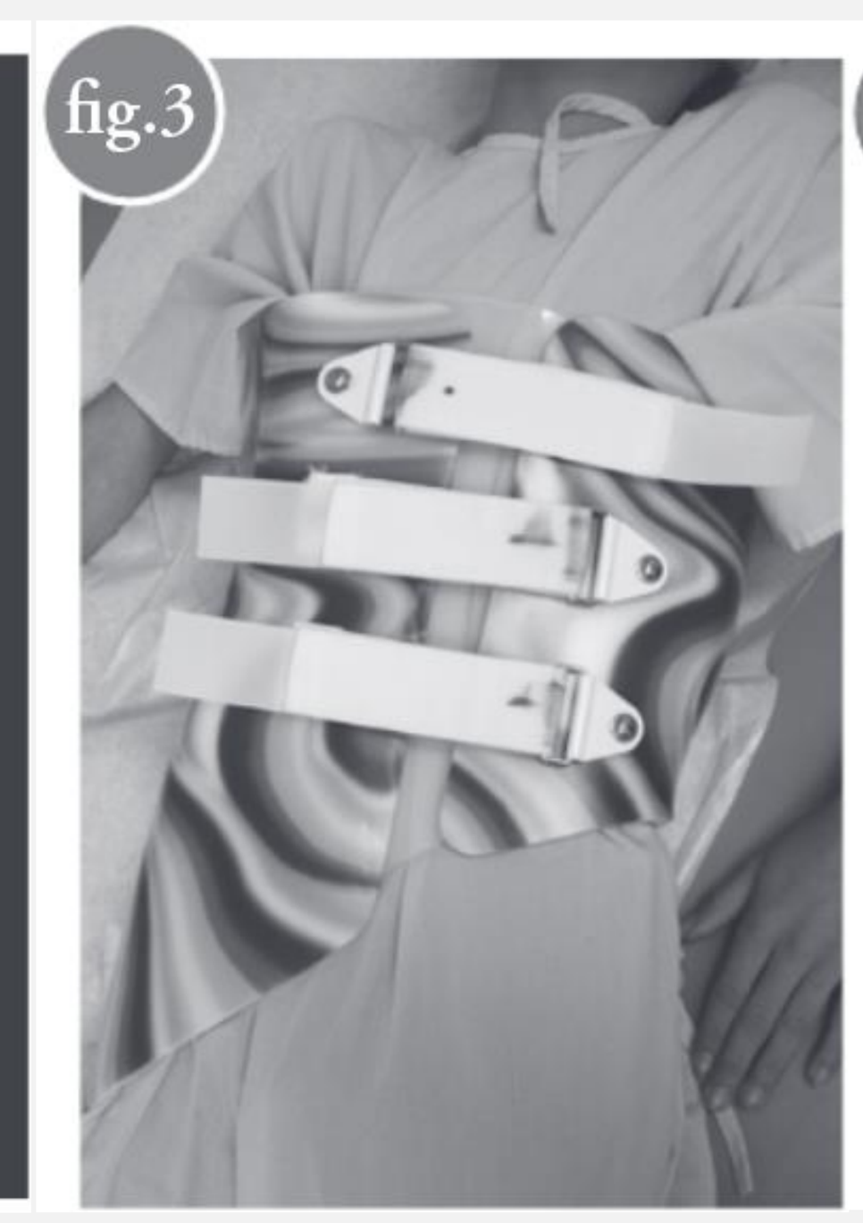


Fig 3. Providence Nighttime brace[1]

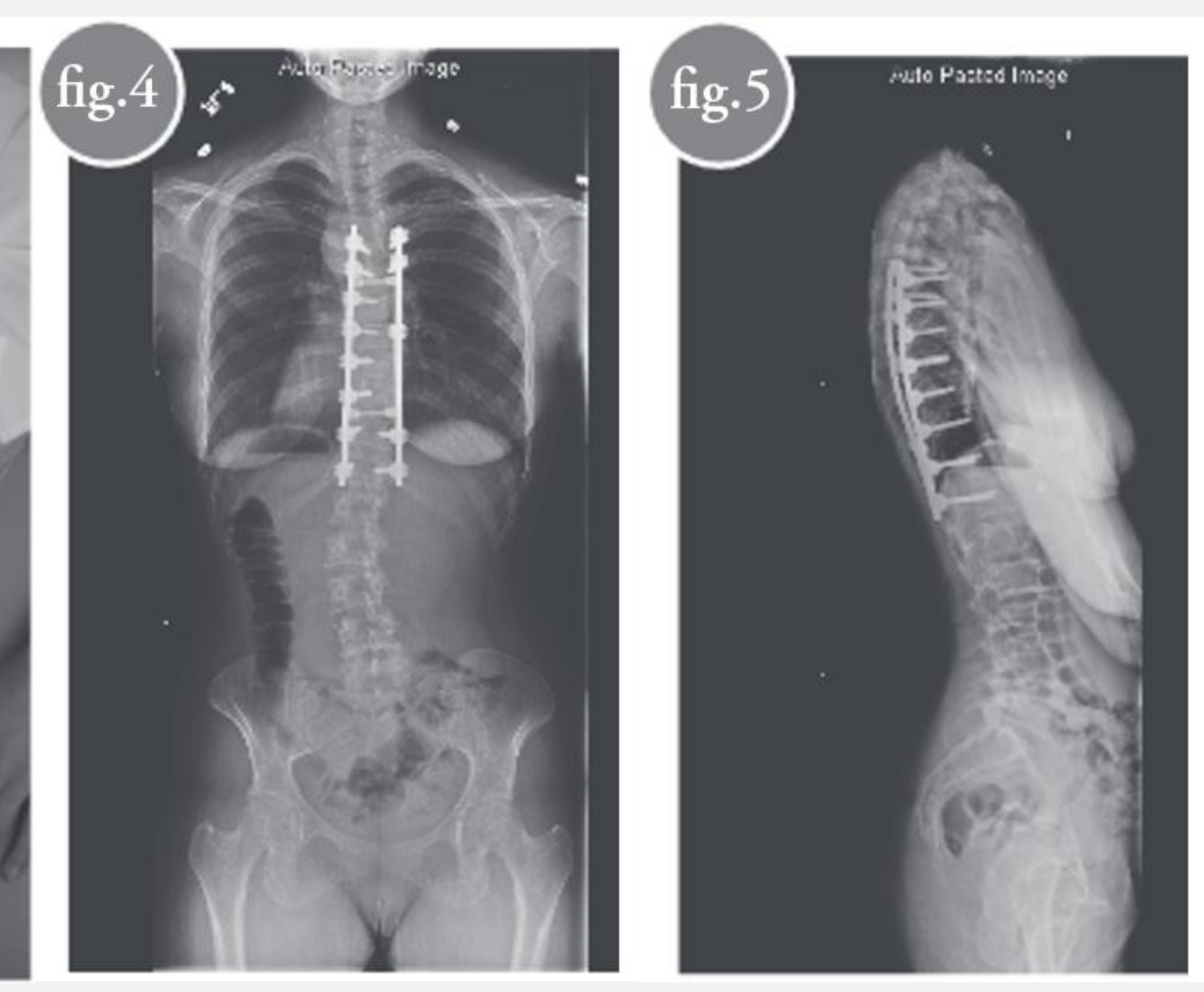


Fig. 4 & 5: X-Ray following posterior spinal fusion surgical treatment[1]

Enhanced Recovery Pathways

Enhanced Recovery After Surgery (ERAS)

Older protocols for surgical recovery typically prescribed general bedrest and slowly easing into mobility. More recently, new protocols lead to better health outcomes and shorter hospital stays, frequently referred to as ERAS or Rapid Recovery Pathways (RRP). ERAS has many changes including an emphasis on earlier mobilization and multimodal treatment. Mobilization elements vary between protocols

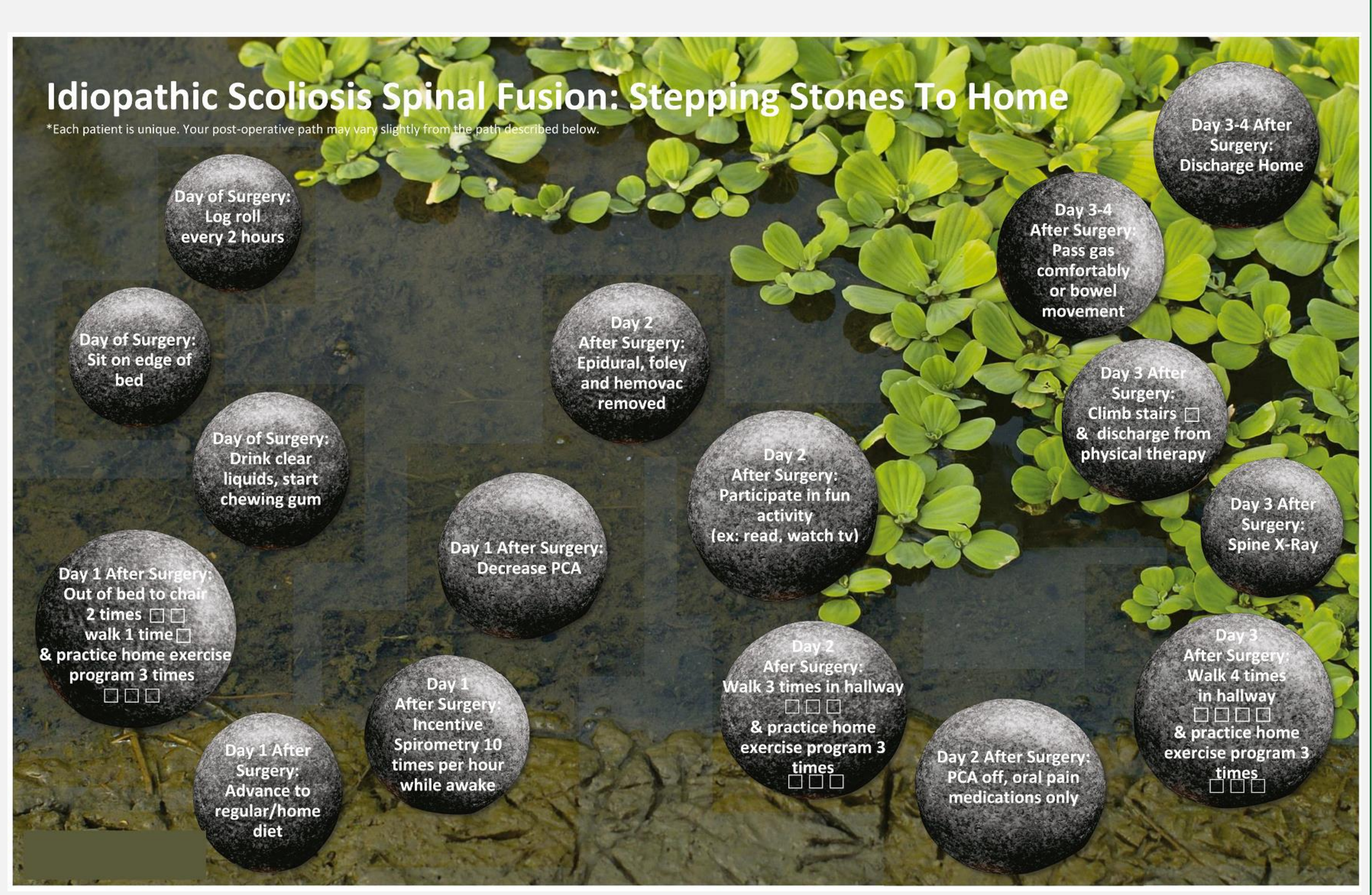


Fig. 6. Chicago Children's Hospital poster guide to recovery milestones in patients' rooms[2]

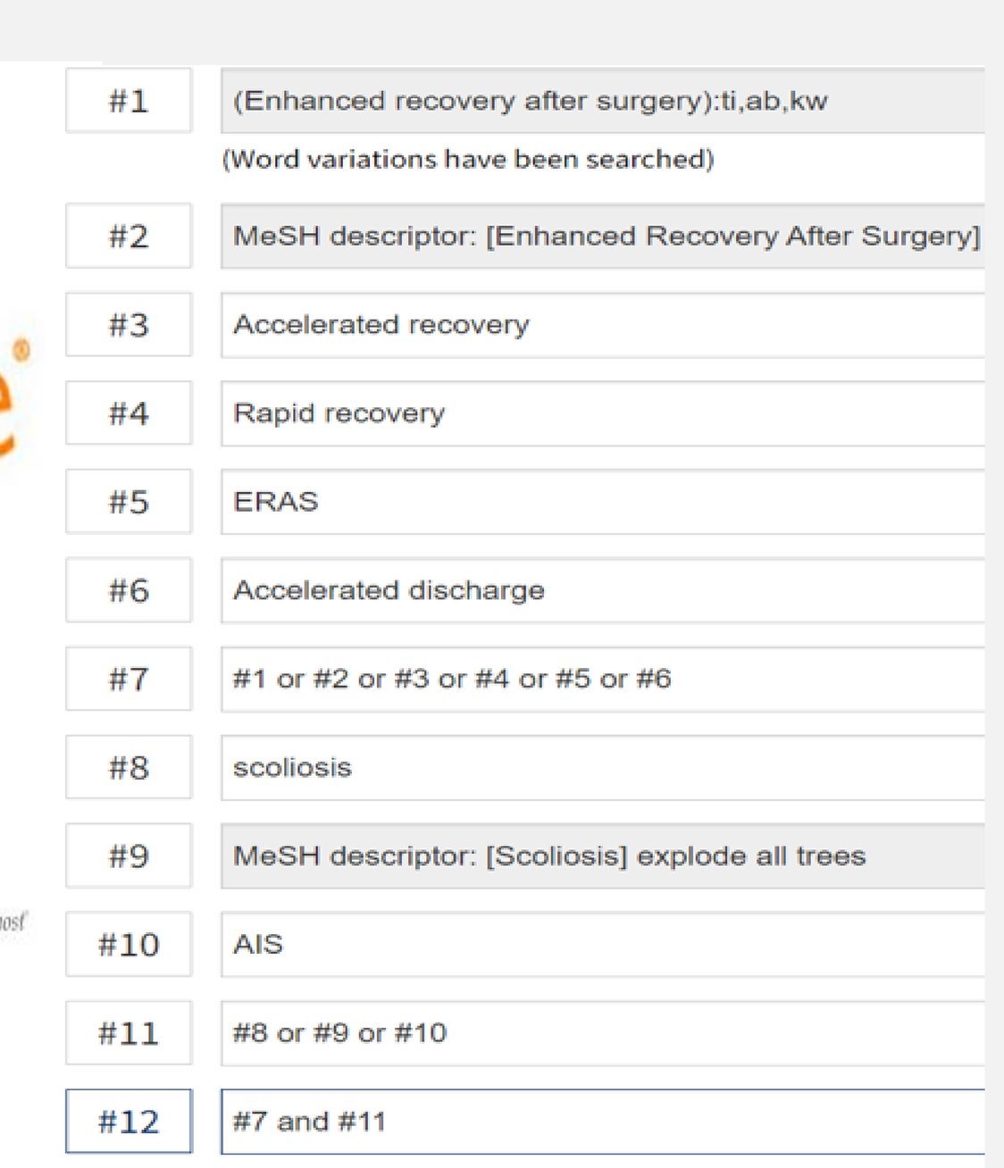
Study Objective & Search

Objective & Methods

ERAS protocols have many elements, but there is a lack of knowledge and variability on when mobilization is prescribed. The **objective of this scoping review** was to document the timing of mobilization and Physical Therapy elements in studies of ERAS in the literature. The Medline, Cochrane Library, EMBASE, and CINAHL databases were searched using keywords for ERAS and scoliosis for children.

PubMed Embase Cochrane CINAHL LIBRARY

Fig. 7: Searched databases



#1	(Enhanced recovery after surgery):ti,ab,kw (Word variations have been searched)
#2	MeSH descriptor: [Enhanced Recovery After Surgery]
#3	Accelerated recovery
#4	Rapid recovery
#5	ERAS
#6	Accelerated discharge
#7	#1 or #2 or #3 or #4 or #5 or #6
#8	scoliosis
#9	MeSH descriptor: [Scoliosis] explode all trees
#10	AIS
#11	#8 or #9 or #10
#12	#7 and #11 with Publication Year from 2020 to present , in Trials

Fig. 8: Cochrane Library search used

Results

Screening & Data

112 unique studies from the search were screened, and 23 met criteria for implemented ERAS after PSF for AIS. A scoping review was completed extracting data on the preoperative protocol, post-op mobilization and physical therapy schedule, length of hospital stay, complications, and pain scores, listed below in Table 1. Many studies did not specify the activities used or times they were implemented.

	Log-roll	Sit up in bed	Standing	Walking	Stairs	ERAS Length of Stay (LOS)	Complications vs non-ERAS	Pain POD2 (ERAS)	Pain POD2 (non-ERAS)
Fletcher et al. 2014	POD0 & POD1 q 2 hr	POD0 parent education POD1 OOB to Chair TID	-	POD1 TID	POD2 begin POD3 conquer	2.92 ± 0.71	15.59% vs 10.4% (ns)	-	-
Muhly et al. 2016	POD0 & POD1 q 2 hr	POD0 Sit on edge of bed	-	POD1 TID	POD2 begin POD3 conquer	4 d	Unspecified	4	4.6
Gornitzsky et al. 2016	POD0 & POD1 q 2 hr	POD1 OOB to chair TID	-	POD1 TID	POD2 begin POD3 conquer	3.5 ± 0.8	5% vs 3% readmissions (ns)	3.9* ± 2.0	4.9* ± 1.8
Thomson et al. 2016		POD0 sits up day of surgery	-	-	-	3.64 ± 0.56 d mdn 3.43 (3.03-5.29)	No complications	4.7 ± 1.7 mdn 4.7 (1.8-7.5)	4.2 ± 2.0 mdn 4.1 (0.0-9.0)
Sanders et al. 2017	-	Evening POD0	Evening POD0	By noon POD1, 2x/day POD2	-	3.7 ± .93	5.55% vs 12.89% (ns)	4.08*	3.22*
Fletcher et al. 2017	→	'Mobilized twice daily starting POD1'	←	←	←	mdn 2.17 95% CI 2.11 - 2.23	7.6% vs 20% *	-	-
Kim et al. 2017	-	POD0	-	POD1 2-3x/day	POD2 goal of 1 flight	3.3 ± 0.7 d Range: 2-4	Unspecified	>3: 78% >5: 19%	>3: 58% >5: 19%
Rao et al. 2017	-	POD1 Mean ~28 hours	-	POD1 optional POD2 short walks	POD4	84.3 ± 27.7 h	3% vs 12% (ns)	3.2 ± 1.6	3.6 ± 1.6
Chan et al. 2017	-	Mean ~21 hours	-	POD1-2	-	86.2 ± 14.4 h	No comparison	-	-
Fletcher et al., 2018	-	POD1 mobilized with PT 3x/day	←	←	←	3.29 ± 0.61	"low incidence, ns"	-	-
Oetgen et al. 2018	-	POD0 patient sits up	-	-	-	3.7 d * IQ 3.3 - 4.1 mdn 3.35	Similar (ns)	3.9	4.3
Yang et al. 2020	-	-	-	Facilitated by noon POD1, 2x/day POD2	-	3.3 d	No comparison	3.9 ± 1.7	No control group
Julien-Marsollier et al. 2020	-	Physio started POD1 (specifics unclear)	←	←	←	4 d (3-16) IQR [4; 5]	4.9% vs 7.3% (ns)	Pain at rest: 2 [1; 4] * At movement: 5 [1; 7] *	Pain at rest: 1 [1; 5] * At movement: 5 [3; 8] *
DeVries et al. 2020	-	-	POD1	POD2 walking in hallway	-	3.4 (3.3-3.5) d	"No difference" (ns)	-	-
Yang et al. 2021	-	-	-	POD1-2 early ambulation	-	5.2 ± 1.6 d (4-11) mdn 5	2.9% vs 4.5% (ns)	-	-
Ahdoot et al. 2021	Physio initiated POD0	←	←	←	←	3.32 ± 0.57 d	Not measured	1.57 ± 1.42 *	2.83 ± 1.12 *
Fletcher et al. 2021	POD0 & POD1 q 2 hr	POD0 parent education POD1 OOB to Chair TID	-	POD1 TID	POD2 begin POD3 conquer	2.2 d	1.4% vs 1.3% (ns)	-	-
Rao et al. 2021	Min q2hrs	POD0	POD1 out of bed to chair	POD1-2	POD3	3.8 ± 0.9 d	Unspecified	mdn 2.5 IQ 0-5	mdn 3 IQ 2-5
Lambrechts et al. 2022	-	-	-	-	-	3.5 ± 1.3 d	3% vs 0% (ns)	-	-
Pico et al. 2022	-	-	-	Mean 2.82 days	-	6.71 d IQ 6.0 - 7.0 mdn 7.0 d	3.1% vs 15.6% (ns)	-	-
van Hoorick et al. 2022	-	-	-	-	-	7.4 d	Not measured	3.74 ± 1.50	3.41 ± 1.37
Colón et al. 2023	-	-	avg 1.0 days	-	-	mdn 2.5 d IQ 2.0 - 3.2	Not provided	mdn 5.0 IQ 3.0-5.0	mdn 6.0 IQ 3.0-7.0
Barnett et al. 2023	-	-	mobilize with PT POD1	←	←	2 days: 2.1% 3 days: 81.2% 4-5 days: 16.7%	6% vs 2.2% (ns)	-	-
Bellaire et al. 2019 (NMS)	-	Mean 1.4 days	POD1 mobilized with PT	←	←	4.0 (1.5) d mdn 3.8 IQ 2.9	33% vs 52% (ns)	-	-
Jian et al. 2023 (EOS)				Mean 2.29 days	-	4.66 ± 0.84 d	Overall ns	-	-

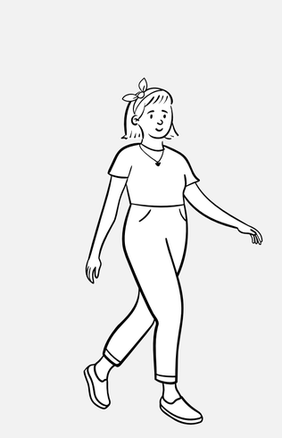
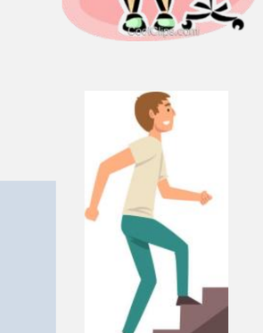
Table 1: Data from scoping review. q: every, OOB: out of bed, BID: 2x/day, TID: 3x/day, NMS: Neuromuscular scoliosis, EOS: Early-onset scoliosis, IQ or [ ]: interquartile range, mdn: median, brackets (): range, *: statistically significant, ns: non-significant, CI: Confidence Interval. Numbers are mean±standard deviation unless otherwise specified.

Summary

Complications were usually fewer with ERAS without statistical significance. The most common time to begin activities were:

Activity	Post-operative Day (POD) initiated
Log-roll	POD0
Sit-up in Bed	POD0, sometimes POD1
Standing by Bed	POD0, sometimes POD1
Walking / Ambulation	POD1
Stairs	POD2, sometimes POD3-4



Discussion

Clinical Implications

Knowing when mobilization is typically prescribed during surgical recovery for children with AIS is helpful for several reasons. Results between different study protocols can be compared to identify how earlier or later prescribed mobilization affects recovery, and the influence of mobilization on complications, pain, and readmission rates.

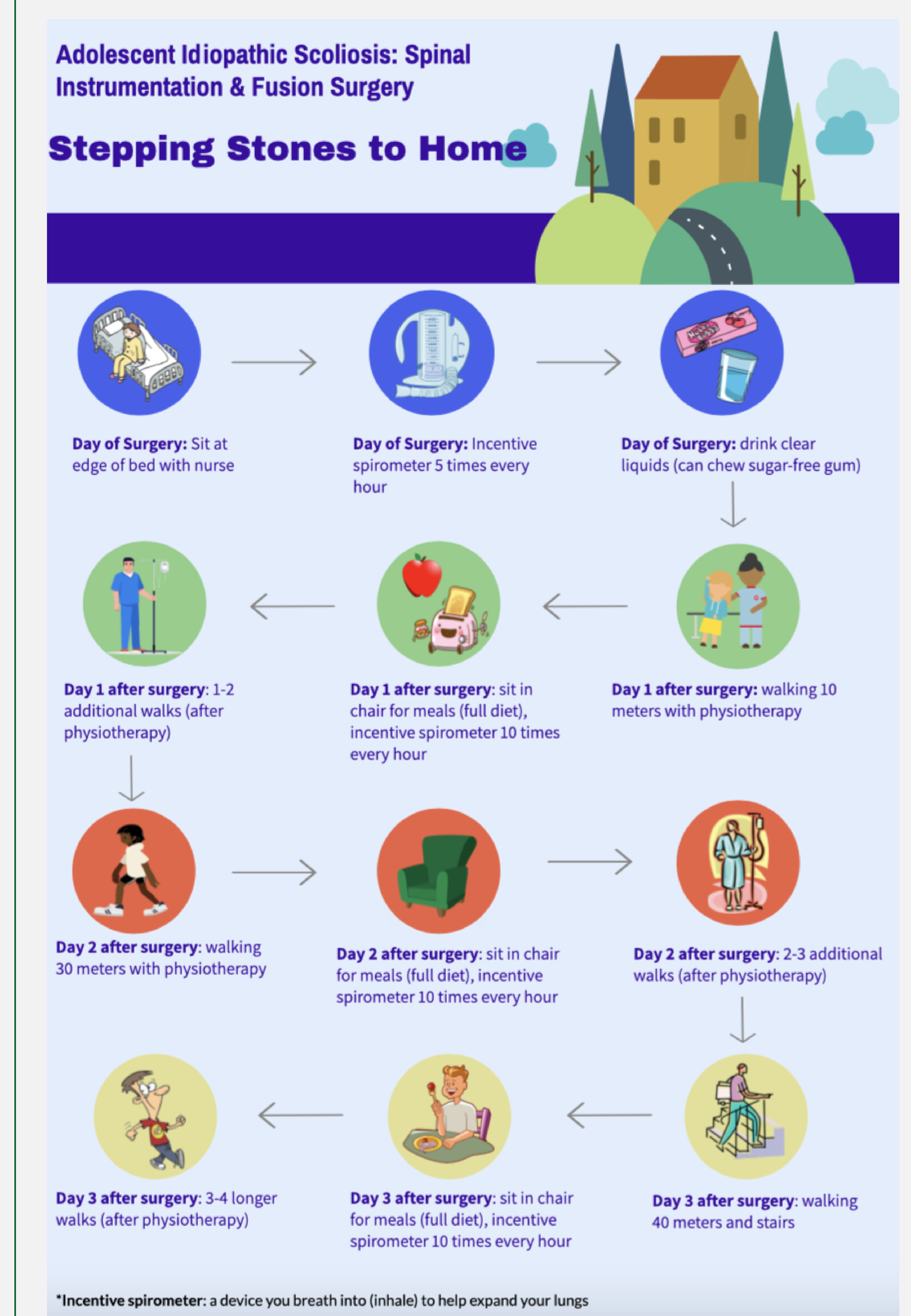


Fig. 9: Current ERAS protocol at the Stollery Hospital

Collected data in protocols also helps clinicians plan for appropriate mobilization timing to lead to improved health outcomes.

These results were recently presented at the Canadian Pediatric Spine Society meeting in Whistler as part of a workshop guiding several Canadian hospitals on implementing ERAS.

Conclusion

Future Direction

Research isolating the effect of timing and progression of PT interventions would be valuable. While earlier mobilization generally leads to better health outcomes, it is difficult to attribute this specifically to PT changes because many drug-related changes were also implemented.

Reporting the specific activity protocol and measuring time to mobility milestones would be valuable data for comparisons. Some studies enable earlier mobilization by engaging families and nurses which we recommend in the future for improving mobility.

In conclusion, ERAS shortened LOS and did not increase complications. Pain was sometimes worse in earlier studies but became less than non-ERAS in more recent studies.

1: Scoliosis Research Society. (n.d.). *Adolescent Idiopathic Scoliosis—A Handbook for Patients*. Scoliosis Research Society. Retrieved March 20, 2024, from https://www.srs.org/Files/Patient-Brochures/Patient.Adolescent_Idiopathic_Scoliosis_Handbook_for_Patients.pdf.

2: Rao, K. E., Krodel, D., Toaz, E. E., Fanelli, J., Hajduk, J., Kato, K., Rychlik, K., King, E., Sarwark, J., Grayhack, J., & Burjek, N. E. (2021). Introduction of an enhanced recovery pathway results in decreased length of stay in patients with adolescent idiopathic scoliosis undergoing posterior spinal fusion: A description of implementation strategies and retrospective before-and-after study of outcomes. *Journal of Clinical Anesthesia*, *75*, 110493. https://doi.org/10.1016/j.jclinane.2021.110493