

BMJ Open

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjopen.bmj.com>).

If you have any questions on BMJ Open's open peer review process please email info.bmjopen@bmj.com

BMJ Open

Study Protocol for the G-SPIRIT trial: A Randomized, Placebo-Controlled, Double-blinded Phase 3 Trial of Granulocyte Colony Stimulating Factor-Mediated Neuroprotection for Acute Spinal Cord Injury

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-019083
Article Type:	Protocol
Date Submitted by the Author:	15-Aug-2017
Complete List of Authors:	<p>Koda, Masao; G-SPIRIT Study Group; University of Tsukuba, Department of Orthopedic Surgery Hanaoka, Hideki; G-SPIRIT Study Group; Chiba University Hospital, Clinical Research Center Sato, Takatoshi; G-SPIRIT Study Group; Chiba University Hospital, Clinical Research Center Fujii, Yasuhisa; G-SPIRIT Study Group; Chiba University Hospital, Clinical Research Center Hanawa, Michiko; G-SPIRIT Study Group; Chiba University Hospital, Clinical Research Center Takahashi, Sho; G-SPIRIT Study Group; Chiba University Hospital, Clinical Research Center Furuya, Takeo; G-SPIRIT Study Group; Graduate School of Medicine, Chiba University, Department of Orthopaedic Surgery Ijima, Yasushi; G-SPIRIT Study Group; Graduate School of Medicine, Chiba University, Department of Orthopaedic Surgery Saito, Junya; G-SPIRIT Study Group; Graduate School of Medicine, Chiba University, Department of Orthopaedic Surgery Kitamura, Mitsuhiro; G-SPIRIT Study Group; Graduate School of Medicine, Chiba University, Department of Orthopaedic Surgery Ohtori, Seiji; G-SPIRIT Study Group; Graduate School of Medicine, Chiba University, Department of Orthopaedic Surgery Matsumoto, Yukei; G-SPIRIT Study Group; University of Tsukuba, Department of Orthopedic Surgery Abe, Tetsuya; G-SPIRIT Study Group; University of Tsukuba, Department of Orthopedic Surgery Watanabe, Kei; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Hirano, Toru; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Ohashi, Masayuki; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Shoji, Hirokazu; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Mizouchi, Tatsuki; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Takahashi, Ikuko; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Kawahara, Norio; G-SPIRIT Study Group; Kanazawa Medical University,</p>

1	
2	
3	
4	Orthopaedic Surgery
5	Kawaguchi, Masahito; G-SPIRIT Study Group; Kanazawa Medical
6	University, Orthopaedic Surgery
7	Orita, Yugo; G-SPIRIT Study Group; Kanazawa Medical University,
8	Orthopaedic Surgery
9	Sasamoto, Takeshi; G-SPIRIT Study Group; Kanazawa Medical University,
10	Orthopaedic Surgery
11	Yoshioka, Masahito; G-SPIRIT Study Group; Kanazawa Medical University,
12	Orthopaedic Surgery
13	Fujii, Masafumi; G-SPIRIT Study Group; Kanazawa Medical University,
14	Orthopaedic Surgery
15	Yonezawa, Katsutaka; G-SPIRIT Study Group; Kanazawa Medical
16	University, Orthopaedic Surgery
17	Soma, Daisuke; G-SPIRIT Study Group; Kanazawa Medical University,
18	Orthopaedic Surgery
19	Taneichi, Hiroshi; G-SPIRIT Study Group; Dokkyo Ika Daigaku, Department
20	of Orthopedic Surgery
21	Takeuchi, Daisaku; G-SPIRIT Study Group; Dokkyo Ika Daigaku,
22	Department of Orthopedic Surgery
23	Inami, Satoshi; G-SPIRIT Study Group; Dokkyo Ika Daigaku, Department
24	of Orthopedic Surgery
25	Moridaira, Hiroshi; G-SPIRIT Study Group; Dokkyo Ika Daigaku,
26	Department of Orthopedic Surgery
27	Ueda, Haruki; G-SPIRIT Study Group; Dokkyo Ika Daigaku, Department of
28	Orthopedic Surgery
29	Asano, Futoshi; G-SPIRIT Study Group; Dokkyo Ika Daigaku, Department
30	of Orthopedic Surgery
31	Shibao, Yosuke; G-SPIRIT Study Group; Dokkyo Ika Daigaku, Department
32	of Orthopedic Surgery
33	Aita, Ikuo; G-SPIRIT Study Group; Tsukuba Medical Center Byoin,
34	Department of Orthopedic Surgery
35	Takeuchi, Yosuke; G-SPIRIT Study Group; Tsukuba Medical Center Byoin,
36	Department of Orthopedic Surgery
37	Mimura, Masaya; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
38	Department of Orthopedic Surgery
39	Shimbo, Jun; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
40	Department of Orthopedic Surgery
41	Someya, Yukio; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
42	Department of Orthopedic Surgery
43	Ikenoue, Sumio; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
44	Department of Orthopedic Surgery
45	Sameda, Hiroaki; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
46	Department of Orthopedic Surgery
47	Takase, Kan; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
48	Department of Orthopedic Surgery
49	Ikeda, Yoshikazu; G-SPIRIT Study Group; Chiba Rosai Byoin, Department
50	of Orthopedic Surgery
51	Nakajima, Fumitake; G-SPIRIT Study Group; Chiba Rosai Byoin,
52	Department of Orthopedic Surgery
53	Hashimoto, Mitsuhiro; G-SPIRIT Study Group; Chiba Rosai Byoin,
54	Department of Orthopedic Surgery
55	Ozawa, Tomoyuki; G-SPIRIT Study Group; Chiba Rosai Byoin, Department
56	of Orthopedic Surgery
57	Hasue, Fumio; G-SPIRIT Study Group; Kimitsu Chuo Byoin, Department of
58	Orthopedic Surgery
59	Fujiyoshi, Takayuki; G-SPIRIT Study Group; Kimitsu Chuo Byoin,
60	Department of Orthopedic Surgery
	Kamiya, Koshiro; G-SPIRIT Study Group; Kimitsu Chuo Byoin, Department
	of Orthopedic Surgery
	Watanabe, Masahiko; G-SPIRIT Study Group; Tokai Daigaku Igakubu
	Seikei Gekagaku, Department of Orthopedic Surgery

1	
2	
3	
4	Katoh, Hiroyuki; G-SPIRIT Study Group; Tokai Daigaku - Isehara Campus,
5	Department of Orthopedic Surgery
6	Matsuyama, Yukihiro; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
7	Department of Orthopedic Surgery
8	Yamato, Yu; G-SPIRIT Study Group; Hamamatsu Ika Daigaku, Department
9	of Orthopedic Surgery
10	Togawa, Daisuke; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
11	Department of Orthopedic Surgery
12	Hasegawa, Tomohiko; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
13	Department of Orthopedic Surgery
14	Kobayashi, Sho; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
15	Department of Orthopedic Surgery
16	Yoshida, Go; G-SPIRIT Study Group; Hamamatsu Ika Daigaku, Department
17	of Orthopedic Surgery
18	Oe, Shin; G-SPIRIT Study Group; Hamamatsu Ika Daigaku, Department of
19	Orthopedic Surgery
20	Banno, Tomohiro; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
21	Department of Orthopedic Surgery
22	Arima, Hideyuki; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
23	Department of Orthopedic Surgery
24	Akeda, Koji; G-SPIRIT Study Group; Mie Daigaku Daigakuin Igakukei
25	Kenkyuka Igakubu, Department of Orthopedic Surgery
26	Kawamoto, Eiji; G-SPIRIT Study Group; Mie Daigaku Daigakuin Igakukei
27	Kenkyuka Igakubu, Department of Orthopedic Surgery
28	Imai, Hiroshi; G-SPIRIT Study Group; Mie Daigaku Daigakuin Igakukei
29	Kenkyuka Igakubu, Department of Orthopedic Surgery
30	Sakakibara, Toshihiko; G-SPIRIT Study Group; Mie Daigaku Daigakuin
31	Igakukei Kenkyuka Igakubu, Department of Orthopedic Surgery
32	Sudo, Akihiro ; G-SPIRIT Study Group; Mie Daigaku Daigakuin Igakukei
33	Kenkyuka Igakubu, Department of Orthopedic Surgery
34	Ito, Yasuo; G-SPIRIT Study Group; Kobe Sekijuji Byoin, Department of
35	Orthopedic Surgery
36	Kikuchi, Tsuyoshi; G-SPIRIT Study Group; Kobe Sekijuji Byoin, Department
37	of Orthopedic Surgery
38	Osaki, Shuhei; G-SPIRIT Study Group; Kobe Sekijuji Byoin, Department of
39	Orthopedic Surgery
40	Tanaka, Nobuhiro; G-SPIRIT Study Group; Hiroshima Daigaku Igakubu
41	Daigakuin Ishiyaku Hokengaku Kenkyuka, Department of Orthopedic
42	Surgery
43	Nakanishi, Kazuyoshi; G-SPIRIT Study Group; Hiroshima Daigaku Igakubu
44	Daigakuin Ishiyaku Hokengaku Kenkyuka, Department of Orthopedic
45	Surgery
46	Kamei, Naosuke; G-SPIRIT Study Group; Hiroshima Daigaku Igakubu
47	Daigakuin Ishiyaku Hokengaku Kenkyuka, Department of Orthopedic
48	Surgery
49	Kotaka, Shinji; G-SPIRIT Study Group; Hiroshima Daigaku Igakubu
50	Daigakuin Ishiyaku Hokengaku Kenkyuka, Department of Orthopedic
51	Surgery
52	Baba, Hideo; G-SPIRIT Study Group; Nagasaki Rosai Byoin, Department of
53	Orthopedic Surgery
54	Okudaira, Tsuyoshi; G-SPIRIT Study Group; Nagasaki Rosai Byoin,
55	Department of Orthopedic Surgery
56	Hiroaki, Konishi; G-SPIRIT Study Group; Nagasaki Rosai Byoin,
57	Department of Orthopedic Surgery
58	Yamaguchi, Takayuki; G-SPIRIT Study Group; Nagasaki Rosai Byoin,
59	Department of Orthopedic Surgery
60	Ito, Keigo; G-SPIRIT Study Group; Chubu Rosai Byoin, Department of
	Orthopedic Surgery
	Katayama, Yoshito; G-SPIRIT Study Group; Chubu Rosai Byoin,
	Department of Orthopedic Surgery
	Matsumoto, Taro; G-SPIRIT Study Group; Chubu Rosai Byoin, Department

	<p>of Orthopedic Surgery Matsumoto, Tomohiro; G-SPIRIT Study Group; Chubu Rosai Byoin, Department of Orthopedic Surgery Idota, Masaru; G-SPIRIT Study Group; Chubu Rosai Byoin, Department of Orthopedic Surgery Kanno, Haruo; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Aizawa, Toshimi; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Hashimoto, Ko; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Eto, Toshimitsu; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Sugaya, Takehiro; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Matsuda, Michiharu; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Fushimi, Kazunari; G-SPIRIT Study Group; Gifu Daigaku Igakubu Daigakuin Igaku Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Nozawa, Satoshi; G-SPIRIT Study Group; Gifu Daigaku Igakubu Daigakuin Igaku Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Iwai, Chizuo; G-SPIRIT Study Group; Gifu Daigaku Igakubu Daigakuin Igaku Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Taguchi, Toshihiko; G-SPIRIT Study Group; Yamaguchi Daigaku Igakubu Daigakuin Igakukei Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Kanchiku, Tsukasa; G-SPIRIT Study Group; Yamaguchi Daigaku Igakubu Daigakuin Igakukei Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Suzuki, Hidenori; G-SPIRIT Study Group; Yamaguchi Daigaku Igakubu Daigakuin Igakukei Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Nishida, Norihiro; G-SPIRIT Study Group; Yamaguchi Daigaku Igakubu Daigakuin Igakukei Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Funaba, Masahiro; G-SPIRIT Study Group; Yamaguchi Daigaku Igakubu Daigakuin Igakukei Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Yamazaki, Masashi; G-SPIRIT Study Group; University of Tsukuba, Department of Orthopedic Surgery</p>
Keywords:	Neurological injury < NEUROLOGY, Spine < ORTHOPAEDIC & TRAUMA SURGERY, Clinical trials < THERAPEUTICS

SCHOLARONE™
 Manuscripts

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Study Protocol for the G-SPIRIT trial: A Randomized, Placebo-Controlled, Double-blinded Phase 3 Trial of Granulocyte Colony Stimulating Factor-Mediated Neuroprotection for Acute Spinal Cord Injury

Corresponding Author: Masao Koda

1-1-1 Tennodai, Tsukuba City, Ibaraki 3058575, Japan

e-mail: masaokod@gmail.com, tel: 81-29-853-3219

Authors: Masao Koda^{1,2}, Hideki Hanaoka^{1,3}, Takatoshi Sato^{1,3}, Yasuhisa Fujii^{1,3}, Michiko Hanawa^{1,3}, Sho Takahashi^{1,3}, Takeo Furuya^{1,4}, Yasushi Ijima^{1,4}, Junya Saito^{1,4}, Mitsuhiro Kitamura^{1,4}, Seiji Ohtori^{1,4}, Yukei Matsumoto^{1,2}, Tetsuya Abe^{1,2}, Kei Watanabe^{1,5}, Toru Hirano^{1,5}, Masayuki Ohashi^{1,5}, Hirokazu Shoji^{1,5}, Tatsuki Mizouchi^{1,5}, Ikuko Takahashi^{1,5}, Norio Kawahara^{1,6}, Masahito Kawaguchi^{1,6}, Yugo Orita^{1,6}, Takeshi Sasamoto^{1,6}, Masahito Yoshioka^{1,6}, Masafumi Fujii^{1,6}, Katsutaka Yonezawa^{1,6}, Daisuke Soma^{1,6}, Hiroshi Taneichi^{1,7}, Daisaku Takeuchi^{1,7}, Satoshi Inami^{1,7}, Hiroshi Moridaira^{1,7}, Haruki Ueda^{1,7}, Futoshi Asano^{1,7}, Yosuke Shibao^{1,7}, Ikuo Aita^{1,8}, Yosuke Takeuchi^{1,8}, Masaya Mimura^{1,9}, Jun Shimbo^{1,9}, Yukio Someya^{1,9}, Sumio Ikenoue^{1,9}, Hiroaki Sameda^{1,9}, Kan Takase^{1,9}, Yoshikazu Ikeda^{1,10}, Fumitake Nakajima^{1,10}, Mitsuhiro Hashimoto^{1,10}, Tomoyuki Ozawa^{1,10}, Fumio Hasue^{1,11}, Takayuki Fujiyoshi^{1,11}, Koshiro Kamiya^{1,11}, Masahiko Watanabe^{1,12}, Hiroyuki Katoh^{1,12}, Yukihiro Matsuyama^{1,13}, Yu Yamamoto^{1,13}, Daisuke Togawa^{1,13}, Tomohiko Hasegawa^{1,13}, Sho Kobayashi^{1,13}, Go Yoshida^{1,13}, Shin Oe^{1,13}, Tomohiro Banno^{1,13}, Hideyuki Arima^{1,13}, Koji Akeda^{1,14}, Eiji Kawamoto^{1,14}, Hiroshi Imai^{1,14}, Toshihiko Sakakibara^{1,14}, Akihiro Sudo^{1,14}, Yasuo Ito^{1,15}, Tsuyoshi Kikuchi^{1,15}, Shuhei Osaki^{1,15}, Nobuhiro Tanaka^{1,16}, Kazuyoshi Nakanishi^{1,16}, Naosuke Kamei^{1,16}, Shinji Kotaka^{1,16}, Hideo Baba^{1,17}, Tsuyoshi Okudaira^{1,17}, Hiroaki Konishi^{1,17}, Takayuki Yamaguchi^{1,17}, Keigo Ito^{1,18}, Yoshito Katayama^{1,18}, Taro Matsumoto^{1,18}, Tomohiro Matsumoto^{1,18}, Masaru Idota^{1,18}, Haruo Kanno^{1,19}, Toshimi Aizawa^{1,19}, Ko Hashimoto^{1,19}, Toshimitsu Eto^{1,19}, Takehiro Sugaya^{1,19}, Michiharu Matsuda^{1,19}, Kazunari Fushimi^{1,20}, Satoshi Nozawa^{1,20}, Chizuo Iwai^{1,20}, Toshihiko Taguchi^{1,21}, Tsukasa Kanchiku^{1,21}, Hidenori Suzuki^{1,21}, Norihiro Nishida^{1,21}, Masahiro Funaba^{1,21}, Masashi Yamazaki^{1,2}

1
2
3
4
5 Affiliations
6

7 ¹G-SPIRIT Study Group is consisted by Nineteen major hospitals in Japan constituting the
8 G-SPIRIT study group
9

10 ²Department of Orthopedic Surgery, University of Tsukuba, Ibaraki

11 ³Clinical Research Center, Chiba University Hospital, Chiba
12

13 ⁴Department of Orthopedic Surgery, Chiba University Graduate School of Medicine, Chiba
14

15 ⁵Department of Orthopedic Surgery, Niigata University Graduate School of Medicine and
16 Dental Sciences, Niigata
17

18 ⁶Department of Orthopedic Surgery, Kanazawa Medical University, Ishikawa
19

20 ⁷Department of Orthopedic Surgery, Dokkyo Medical University, Tochigi
21

22 ⁸Department of Orthopedic Surgery, Tsukuba Medical Center, Ibaraki
23

24 ⁹Department of Orthopedic Surgery, Funabashi Municipal Medical Center, Chiba
25

26 ¹⁰Department of Orthopedic Surgery, Chiba Rosai Hospital, Chiba
27

28 ¹¹Department of Orthopedic Surgery, Kimitsu Chuo Hospital, Chiba
29

30 ¹²Department of Orthopedic Surgery, Tokai University School of Medicine, Kanagawa
31

32 ¹³Department of Orthopedic Surgery, Hamamatsu University School of Medicine, Shizuoka
33

34 ¹⁴Department of Orthopedic Surgery, Graduate School of Medicine, Mie University, Mie
35

36 ¹⁵Department of Orthopedic Surgery, Kobe Red Cross Hospital, Hyogo
37

38 ¹⁶Department of Orthopedic Surgery, Graduate School of Biomedical Sciences, Hiroshima
39 University, Hiroshima

40 ¹⁷Department of Orthopedic Surgery, Nagasaki Rosai Hospital, Nagasaki
41

42 ¹⁸Department of Orthopedic Surgery, Chubu Rosai Hospital, Aichi
43

44 ¹⁹Department of Orthopedic Surgery, Tohoku University School of Medicine, Miyagi
45

46 ²⁰Department of Orthopedic Surgery, Gifu University School of Medicine, Gifu
47

48 ²¹Department of Orthopedic Surgery, Yamaguchi University Graduate School of Medicine,
49 Yamaguchi
50

51
52 Word Count: 2516
53
54
55
56
57

Abstract

Introduction: Granulocyte Colony Stimulating Factor (G-CSF) is generally used for neutropenia. Previous experimental studies revealed that G-CSF promoted neurological recovery after spinal cord injury (SCI). Next we moved to early phase of clinical trials. In a phase 1/2a trial, no adverse events were observed. Next, we conducted a non-randomized, non-blinded, comparative trial, which suggested the efficacy of G-CSF for promoting neurological recovery. Based on those results, we are now performing a phase 3 trial.

Methods and Analysis: The objective of this study is to prove the efficacy of G-CSF for acute SCI. The study design is a prospective, multicenter, randomized, double-blinded, placebo-controlled comparative study. The current trial includes cervical SCI (severity of American Spinal Injury Association (ASIA) Impairment Scale B/C) within 48 hours after injury. Patients are randomly assigned to G-CSF and placebo groups. The G-CSF group is administered 400 $\mu\text{g}/\text{m}^2/\text{d}\times 5\text{d}$ of G-CSF in normal saline via intravenous infusion for 5 consecutive days. The placebo group is similarly administered a placebo. Our primary endpoint is changes in ASIA motor scores from baseline to 3 months. Each group includes 44 patients (88 total patients). This trial is funded by the Center for Clinical Trials, Japan Medical Association.

Ethics and Dissemination: The study was approved by the Institutional Review Board of each institution and will be conducted according to the principles of the World Medical Association Declaration of Helsinki and in accordance with the Japanese Medical Research Involving Human Subjects Act and other guidelines, regulations and Acts. Results of the clinical study will be submitted to the head of the respective clinical study site as a report after conclusion of the clinical study by the sponsor-investigator. Even if the results are not favorable despite conducting the clinical study properly, the data will be published as a paper.

Registration: UMIN000018752

<https://upload.umin.ac.jp/cgi-open-bin/ctr/ctr.cgi?function=brows&action=brows&type=summary&recptno=R000021694&language=J>

Strengths and Limitations of This Study

Strengths

- ✓ Novel drug therapy for acute spinal cord injury is much-needed.
- ✓ Randomized, placebo-controlled, double-blinded design can eliminate bias.

Limitations

- ✓ Acute spinal cord injury patients are difficult to recruit to the trial.
- ✓ Patient's neurological status in acute phase is unstable, possibly resulting in dispersion of the patient's background.
- ✓ Concealment must be performed very strictly because G-CSF apparently increases

white blood cell count.

Introduction

Spinal cord injury (SCI) is a devastating injury by which the patient can suffer from long-lasting severe sequelae including palsy of extremities, sensory disturbance, bowel/bladder/sexual dysfunction, and neuropathic pain. Conceptually, SCI is divided into two chronological phases: a primary and a secondary phase. Primary injury is mechanical damage to spinal cord tissue itself caused by fracture and/or dislocation or compression. Secondary injury is triggered by the primary injury and is a biological reaction of the spinal cord, which includes ischemia, hemorrhage, excitotoxicity, hyperpermeability, and inflammation¹. Because secondary injury can be the main target of treatment, extensive laboratory and clinical investigation of neuroprotection is needed to manage secondary injury².

To date, the only approved neuroprotective therapy for SCI is massive methylprednisolone sodium succinate (MPSS) therapy based on the NASCIS 2 study³. However, recent reports revealed that MPSS shows only a modest effect for SCI. In addition, several reports have described adverse events induced by MPSS for SCI including infections (pneumonia, urinary tract infection) and gastrointestinal disorders (gastric ulcer, etc.)⁴. Therefore, the use of MPSS for SCI has become controversial⁵. Accordingly, a new therapeutic drug for SCI is desirable.

Granulocyte colony-stimulating factor (G-CSF, generic name: filgrastim) is a growth factor that affects the hematopoietic system, promoting differentiation, proliferation, and survival of granulocytes⁶. Clinically, in Japan, G-CSF is administered to patients with leukopenia, and to peripheral stem cell transplantation donors, G-CSF is administered to mobilize hematopoietic stem cells into the peripheral blood⁷. In the central nervous system, G-CSF has properties to mobilize the movement of bone marrow cells into the brain⁸ and spine, and in a stroke model, has shown neuroprotective properties⁹. In other countries, clinical studies of the effects of G-CSF in cerebral infarction have been reported¹⁰.

To prove the hypothesis that G-CSF has neuroprotective properties against SCI, G-CSF was administered to rat and mouse animal models of spinal cord injury, and hind limb

1
2
3
4
5
6 function improved significantly after administration of G-CSF. Further investigations into
7 the mechanism of action of G-CSF in SCI were conducted. Data obtained to date identify
8 the following properties of G-CSF: [1] mobilization of bone marrow-derived stem cells
9 causing their biointegration at the site of SCI¹¹, [2] direct inhibition of nerve cell death¹²,
10 [3] protection of the myelin sheath by inhibiting oligodendrocyte cell death¹³, [4] inhibition
11 of inflammatory cytokine expression (TNF- α , IL-1 β)¹³, and [5] promotion of
12 neovascularization¹⁴. These properties suggest that G-CSF has a neuroprotective effect in
13 acute SCI.
14
15

16
17
18
19 Based on these properties, a phase 1/2a clinical study was conducted where the main
20 objective was to confirm the safety and feasibility of G-CSF for treatment of patients with
21 acute SCI¹⁵. This study was an open-label, dose-titrating study with no control group. As
22 the initial step, 5 patients were given 5 $\mu\text{g}/\text{kg}/\text{day}$ of G-CSF for 5 consecutive days by i.v.
23 infusion, and as the second step, 11 patients were given 10 $\mu\text{g}/\text{kg}/\text{day}$ of G-CSF for 5
24 consecutive days by i.v. infusion. No serious adverse events were noted, and the safety of
25 G-CSF administration in patients with acute SCI was confirmed¹⁵.
26
27
28
29

30
31 As a next step, to validate the efficacy of G-CSF in neuroprotective treatment, a
32 multicenter, prospective, nonrandomized, nonblinded, comparative control study (phase 2b
33 clinical trial) was conducted¹⁶. Based on the results of the previous phase 1/2a clinical trial,
34 the dosage and duration of treatment with G-CSF in this study was 10 $\mu\text{g}/\text{kg}/\text{day}$ for 5
35 consecutive days. Patients with acute cervical SCI (within 48 h of injury) were registered in
36 the clinical trial and allocated to either the G-CSF group (G-CSF 10 $\mu\text{g}/\text{kg}/\text{day} \times 5$ days i.v.
37 infusion) or control group (no G-CSF administration) at each treatment facility. A total of
38 19 patients in the G-CSF group and 26 patients in the control group were observed for 3
39 months or longer. American Spinal Injury Association (ASIA) motor score (motor: 0 to 100
40 points) was compared between the groups. ASIA motor scores were 26.1 ± 18.9 in the
41 G-CSF group and 12.2 ± 14.7 in the control group showing a significant improvement of
42 motor paralysis in the G-CSF group ($p < 0.01$). In addition, in cases that could be followed
43 for 1 year or longer, a significant improvement of ASIA motor score was observed in the
44 G-CSF group¹⁶.
45
46
47
48
49
50
51
52
53
54
55
56
57

1
2
3
4
5 Based on results of these preclinical and early phase clinical trials, we are now
6 conducting a phase 3 confirmative trial.

7 8 9 *Specific Objective*

10 The objective of this study is to prove the efficacy of G-CSF for improving motor
11 paralysis in acute SCI.
12
13

14 15 **Methods and Analysis**

16 17 *Design of the study*

18 The study design of the current trial is a prospective, multicenter, randomized,
19 double-blinded, placebo-controlled comparative study.
20
21
22
23

24 25 *Study Procedures*

26 Patients will be randomly assigned to G-CSF and placebo groups. A central registration
27 system will be used for dynamic randomization into the investigational treatment group
28 (G-CSF) and control group (placebo) based on age at registration (16–64 years of age, or
29 65–84 years of age) and severity of paralysis (AIS B or C) at 48 h after injury. Each subject
30 will be randomly allocated to either the investigational treatment group (G-CSF) or control
31 group (placebo) in a 1 to 1 ratio. The subject registration center uses a program based on an
32 appropriate computer algorithm to allocate patients into groups.
33
34
35
36
37

38 The G-CSF group will be administered $400 \mu\text{g}/\text{m}^2/\text{d} \times 5\text{d}$ of G-CSF in normal saline via
39 intravenous infusion for 5 consecutive days. The placebo group will be similarly
40 administered a placebo. Allocation will be concealed between blinded evaluators of
41 efficacy/safety and those for laboratory data, as G-CSF markedly increases white blood cell
42 counts that can reveal patient treatment.
43
44
45
46

47 Our primary endpoint is changes in ASIA motor scores from baseline to 3 months
48 calculated as follows: 3-month ASIA motor score change = 3-month ASIA motor score –
49 pretreatment ASIA motor score.
50
51

52 Secondary endpoints are as follows. [1] Change in ASIA motor scores at 6 months and
53 12 months after G-CSF administration compared with pretreatment. [2] Changes in sensory
54
55
56
57

1
2
3
4
5
6 paralysis over time: change in ASIA sensory scores at 3 months, 6 months, and 12 months
7 after G-CSF administration compared with pretreatment. [3] Severity of functional
8 compromise because of paralysis: AIS before administration and at 3, 6, and 12 months
9 after administration of G-CSF. [4] Percentage of responders: percentage of patients whose
10 AIS improved by 1 grade or more at 3, 6, and 12 months after administration compared
11 with before administration of G-CSF. [5] Neurological level of injury (NLI): percentage of
12 patients whose NLI decreased by 1 grade or more at 3, 6, or 12 months after administration
13 of G-CSF compared with pretreatment. [6] SCIM: change in ASIA motor scores at 3, 6, and
14 12 months after G-CSF administration compared with pretreatment [7] EQ-5D: measured
15 EQ-5D efficacy scores at 3, 6, and 12 months after G-CSF.
16
17
18
19
20
21
22

23 Each group will include 44 patients (88 patients in total). Our protocol was approved by
24 the Pharmaceuticals and Medical Device Agency and this trial will be funded by the Center
25 for Clinical Trials, Japan Medical Association.
26
27
28
29

30 *Inclusion*

31 Inclusion criteria are as follows. [1] Patients with cervical SCI (severity of AIS B/C)
32 within 48 h of injury. [2] Patients reassessed for neurological status at 48 h after injury, and
33 those whose palsy is AIS B/C will be enrolled. [3] Patients with neurological level of injury
34 between C4 and C7. [4] Patients with age of 16 to 85 years. [5] Patients who agree to
35 participate in the current trial and from whom informed consent was obtained orally and in
36 writing. [6] Patients who can be followed up for 12 months after SCI.
37
38
39
40
41
42
43

44 *Exclusion*

45 Exclusion criteria are as follows. [1] Patients with neurological recovery to AIS D at
46 neurological reassessment 48 h after SCI, because only AIS B/C patients will be included
47 to standardize the severity of paresis in order to stratify the patients at the initiation of drug
48 administration. [2] Allergy to G-CSF. [3] Hematological malignancy, [4] within 6 months
49 after invasive coronary intervention, [5] splenomegaly, or [6] pregnancy, [7] neurological
50 disorders that can affect neurological evaluation in the present trial, [8] fracture of
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5 extremities that can affect the neurological evaluation. Exclusion criteria 2 - 6 are set for
6 safety and criteria 1, 7 and 8 are set to maintain homogeneity of the patient population
7 enrolled.
8
9

10 11 12 *Concealment*

13
14 Patients will be administered drug or placebo and be evaluated in a double-blinded
15 manner. An evaluator blinded to the treatment will take charge of patient evaluation
16 including clinical findings and paresis, without laboratory data because G-CSF induces an
17 apparent increase of white blood cell count that makes it easy to distinguish G-CSF and
18 placebo treatment. Therefore, a non-blinded evaluator for laboratory data will be assigned
19 to evaluate laboratory data alone. From a safety point-of view, the dose of G-CSF will be
20 modulated according to excessive increase of white blood cell count as shown in Table 2.
21 Therefore, a non-blinded evaluator will instruct the pharmacy to modulate the dose of
22 G-CSF based on white blood cell count.
23
24
25
26
27
28
29
30

31 *Sample Size Calculation*

32
33 The target sample size for this randomized trial is 88. This number is based on the
34 results of previous clinical trials¹⁶. The estimated group difference (\pm standard deviation) of
35 change in ASIA motor scores from baseline to 3 months is 13.9 (\pm 21.9). A sample size of
36 44 patients in each group will provide 80% power to detect a difference of the change in
37 ASIA motor scores between the G-CSF and the placebo treatments, using a mixed-effects
38 models for repeated measures (MMRM) at a two-sided 5% level of significance. A
39 common correlation of 0.25 at each time point is assumed. A dropout rate of 10% is
40 allowed. Thus, the total sample size of 88 patients is required for the trial.
41
42
43
44
45
46
47
48

49 *Statistical analyses*

50 The analyses of the primary and secondary end points will be performed in a full
51 analysis set, which includes all patients who: (1) took at least one course of treatment
52 during the study; (2) do not present any serious violation of the study protocol; and (3) have
53
54
55
56
57

1
2
3
4
5 data collected after commencement of treatment. For the baseline characteristics, summary
6 statistics will comprise frequencies and proportions for categorical variables, and means
7 and SDs for continuous variables. The patient characteristics will be compared using a
8 chi-square test for categorical variables, and a *t* test or Wilcoxon rank sum test for
9 continuous variables.
10
11
12
13

14 For the primary analysis, aimed at comparing treatment effects, a change in ASIA motor
15 score from baseline to 3 months and its 95% confidence interval (CI) will be estimated
16 using the MMRM. To test for significant association of the primary endpoint, a mixed
17 effects model for repeated measures with an unstructured covariance matrix will be applied
18 to adjust for age (<65 years or ≥65 years) and AIS at 48 h after the injury (B or C).
19
20
21
22

23 For the secondary analysis, the change in ASIA motor score will be compared using a
24 Student *t* test and the 95% CI will be estimated. The same method will be applied to change
25 in sensory score, SCIM, and EQ-5D. A chi-squared test will be applied to the frequencies of
26 the responder in AIS and of the improvement in NLI. The frequency of AIS will be
27 summarized. The frequency of AEs will be compared using a Fisher exact test.
28
29
30

31 All comparisons are planned and all *p* values will be two sided. *p* < 0.05 will be
32 considered significant. All statistical analyses will be performed using SAS software
33 (version 9.4; SAS Institute, Cary, NC, USA). The statistical analysis plan will be developed
34 by the principal investigator and the biostatistician before completion of patient recruitment
35 and fixing of data.
36
37
38
39
40
41

42 *Data Monitoring Committee*

43 The data monitoring committee consists of three clinical trial specialists, including a
44 biostatistician, who are independent from the current study. The committee will meet at
45 least 2 times per year and all the data obtained by the current trial will be checked by the
46 committee.
47
48
49
50
51

52 *Adverse Events*

53 As for safety evaluation, adverse events will be collected as follows. “Adverse events”
54
55
56
57

1
2
3
4
5 refers to any untoward symptom or disease or signs of such (including clinical laboratory
6 data abnormalities) in a clinical investigation subject after informed consent and does not
7 necessarily have a causal relationship with the investigational product (G-CSF).
8
9

10 Increases in white blood counts will be considered an adverse event only when the
11 count exceeds 50,000/ μ L from the perspective of a pharmacological effect of G-CSF, and
12 any values below this will not be handled as an adverse event.
13
14

15 All adverse events will code terminology used by the investigators according to the ICH
16 International Medical Dictionary for Regulatory Activities Japanese version (MedDRA/J).
17
18
19

20 21 **Ethics and Dissemination**

22 *Ethics*

23
24 The study was approved by the Institutional Review Board (IRB) of each institutions
25 involved to the present trial and will be conducted according to the principles of the World
26 Medical Association (WMA) Declaration of Helsinki—Ethical Principles for Medical
27 Research Involving Human Subjects with the amendments made in Seoul, South Korea,
28 October 2008, with a Note of Clarification on Paragraph 29 added by the WMA General
29 Assembly, Washington 2002; Note of Clarification on Paragraph 30 added by the WMA
30 General Assembly, Tokyo 2004, and in accordance with the Japanese Medical Research
31 Involving Human Subjects Act (WMO) and other guidelines, regulations and Acts.
32
33
34
35
36
37

38 *Public Disclosure and Publication Policy*

39
40 Results of the clinical study will be submitted to the head of the respective clinical
41 study site as a report after conclusion of the clinical study by the sponsor-investigator
42 (includes study coordinating investigator). Even if the results are not favorable despite
43 conducting the clinical study properly, the data will be published as a paper. Other
44 sponsor-investigators (including the clinical study coordinating investigator), if they plan to
45 publicize the data from this study in a specialized academic society conference or other
46 external site, must first obtain permission from the other principal investigators and
47 investigational product provider. In publicizing the results, the confidentiality of the
48 subjects will be maintained and proofread in advance by the other sponsor-investigators
49
50
51
52
53
54
55
56
57
58
59
60

(includes coordinating investigator) and investigational product provider.

Discussion

The current trial is a confirmative trial to elucidate the therapeutic efficacy of G-CSF for SCI. If the current trial can successfully show significant improvement of motor paralysis of SCI by G-CSF, we will move forward to drug approval application to the Ministry for Health and Labor, Japan. The entire protocol of the current trial was approved beforehand for the initiation of the current trial by the Japanese Pharmaceutical and Medical Device Agency (PMDA). The PMDA will also permit a drug approval application if significant efficacy of G-CSF for SCI is proven.

The current trial is an important milestone for SCI clinics and research to explore G-CSF for SCI.

Trial Status

The present trial is now on-going.

Trial Sites

Nineteen major hospitals in Japan constituting the G-SPIRIT study group as follows: Tohoku University Hospital, Miyagi; Niigata University, Niigata; Dokkyo University Hospital, Tochigi; Tsukuba University Hospital, Ibaraki; Tsukuba Medical Center, Ibaraki; Chiba University Hospital, Chiba; Funabashi Municipal Medical Center, Chiba; Kimitsu Chuo Hospital, Chiba; Chiba Rosai Hospital, Chiba; Tokai University Hospital, Kanagawa; Hamamatsu University Hospital, Shizuoka; Gifu University Hospital, Gifu; Chubu Rosai Hospital, Aichi; Mie University Hospital, Mie; Kanazawa Medical Collage, Ishikawa; Kobe Red Cross Hospital, Hyogo; Hiroshima University Hospital, Hiroshima; Yamaguchi University Hospital, Yamaguchi; and Nagasaki Rosai Hospital, Nagasaki.

Funding Statement

This trial is supported by Center for Clinical trials, Japan Medical Association, Japan.

Competing Interests

No authors have any competing interests to declare.

Contributorship Statement

MK, TF and MY contributed to planning and conduct of the present trial and to reporting the present protocol paper. HH, TS, YF, MH and ST contributed to conception and design of the present trial protocol and to reporting the present protocol paper. YI, JS, MK, SO, YM, TA, KW, TH, MO, HS, TM, IT, NK, MK. YO, TS, MY, MF, KY, DS, HT, DT, SI, HM, HU, FA, YS, IA, YT, MM, JS, YS, SI, HS, KT, YI, FN, MH, TO, FH, TF, KK, MW, HK, YM, YY, DT, TH, SK, GY, SO, TB, HA, KA, EK, HI, TS, AS, YI, TK, SO, NT, KN, NK, SK, HB, TO, HK, TY, IK, KY, TM, TM, IM, HK, TA, KH, TE, TS, MM, KF, SN, CI, TT, TK, HS, NN and MF contributed to conducting the present trial and to acquisition of data.

References

1. Oyinbo CA. Secondary injury mechanisms in traumatic spinal cord injury: a nugget of multiply cascade. *Acta Neurobiol Exp* 2011;71:281-299.
2. Karsy M, Hawryluk G. Pharmacologic Management of Acute Spinal Cord Injury. *Neurosurg Clin N Am* 2017;28:49-62. doi: 10.1016/j.nec.2016.07.002.
3. Bracken MB, Shepard MJ, Collins WF, et al. A randomized controlled trial of methylprednisolone or naloxone in the treatment of acute spinal cord injury: results of the second national acute spinal cord injury study. *N Engl J Med* 1990;322:1405-1411.
4. Matsumoto T, Tamaki T, Kawakami M, et al. Early complications of high-dose methyl-prednisolone sodium succinate treatment in the follow-up of acute cervical spinal cord injury. *Spine* 2001;26: 426-430.
5. Hurlbert RJ, Hadley, Walters BC, et al. Pharmacological Therapy for Acute Spinal cord Injury. *Neurosurgery* 2013;72: 93-105.
6. Nicola NA, Metcalf D, Matsumoto M, Johnson GR. Purification of a factor inducing

- 1
2
3
4
5 differentiation in murine myelomonocytic leukemia cells. Identification as
6 granulocyte colony-stimulating factor. *J Biol Chem* 1983;258: 9017-9023.
- 7
8
9 7. Roberts AW: G-CSF: a key regulator of neutrophil production, but that's no all!
10 *Growth Factors* 2005;23: 33–41.
- 11
12 8. Kawada H, Takizawa S, Takanashi T, et al. Administration of hematopoietic
13 cytokines in the subacute phase after cerebral infarction is effective for functional
14 recovery facilitating proliferation of intrinsic neural stem/progenitor cells and
15 transition of bone marrow-derived neuronal cells. *Circulation* 2006;113: 701-710.
- 16
17
18 9. Schneider A, Kruger C, Steigleder T, et al. The hematopoietic factor G-CSF is a
19 neuronal ligand that counteracts programmed cell death and drives neurogenesis. *J*
20 *Clin Invest* 2005;115: 2083-2098.
- 21
22
23 10. Shyu WC, Lin SZ, Lee CC, Liu DD, Li H. Granulocyte colony-stimulating factor for
24 acute ischemic stroke: a randomized controlled trial. *CMAJ* 2006;174: 927-933.
- 25
26
27 11. Koda M, Nishio Y, Kamada T, et al. Granulocyte colony-stimulating factor (G-CSF)
28 mobilizes bone marrow-derived cells into injured spinal cord and promotes functional
29 recovery after compression-induced spinal cord injury in mice. *Brain Res* 2007;1149:
30 223-231.
- 31
32
33 12. Nishio Y, Koda M, Kamada T, et al. Granulocyte colony-stimulating factor (G-CSF)
34 attenuates neuronal death and promotes functional recovery after spinal cord injury in
35 mice. *J Neuropathol Exp Neurol* 2007;66: 724-731.
- 36
37
38 13. Kadota R, Koda M, Kawabe J, et al. Granulocyte colony-stimulating factor (G-CSF)
39 protects oligodendrocyte and promotes hindlimb functional recovery after spinal cord
40 injury in rats. *PLoS One* 2012;7:e50391.
- 41
42
43 14. Kawabe J, Koda M, Hashimoto M, et al. Granulocyte colony-stimulating factor
44 (G-CSF) exerts neuroprotective effects via promoting angiogenesis after spinal
45 cord injury in rats. *J Neurosurg Spine* 2011;15: 414-421.
- 46
47
48 15. Takahashi H, Yamazaki M, Okawa A, et al. Neuroprotective therapy using
49 granulocyte colony-stimulating factor for acute spinal cord injury: a phase I/IIa
50 clinical trial. *Eur Spine J* 2012;21:2580-2587.
- 51
52
53
54
55
56
57
58
59
60

- 1
2
3
4
5
6 16. Inada T, Takahashi H, Yamazaki M, et al. A multicenter prospective non-randomized
7 controlled clinical trial to prove neurotherapeutic effects of granulocyte
8 colony-stimulating factor (G-CSF) for acute spinal cord injury: Analyses of
9 follow-up cases after at least one year. *Spine* 2014;39:213-219.
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57



CONSORT 2010 checklist of information to include when reporting a randomised trial*

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a randomised trial in the title	1
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	3
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale	4-5
	2b	Specific objectives or hypotheses	6
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	6
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	N/A
Participants	4a	Eligibility criteria for participants	7
	4b	Settings and locations where the data were collected	11
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	6-7
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	6-7
	6b	Any changes to trial outcomes after the trial commenced, with reasons	N/A
Sample size	7a	How sample size was determined	8
	7b	When applicable, explanation of any interim analyses and stopping guidelines	N/A
Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	6
	8b	Type of randomisation; details of any restriction (such as blocking and block size)	6
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	8
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	6
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those	8

1			
2		assessing outcomes) and how	
3			
4		11b If relevant, description of the similarity of interventions	N/A
5	Statistical methods	12a Statistical methods used to compare groups for primary and secondary outcomes	8-9
6		12b Methods for additional analyses, such as subgroup analyses and adjusted analyses	N/A
7			
8	Results		
9	Participant flow (a	13a For each group, the numbers of participants who were randomly assigned, received intended treatment, and	N/A
10	diagram is strongly	were analysed for the primary outcome	
11	recommended)	13b For each group, losses and exclusions after randomisation, together with reasons	N/A
12	Recruitment	14a Dates defining the periods of recruitment and follow-up	N/A
13		14b Why the trial ended or was stopped	N/A
14	Baseline data	15 A table showing baseline demographic and clinical characteristics for each group	N/A
15	Numbers analysed	16 For each group, number of participants (denominator) included in each analysis and whether the analysis was	N/A
16		by original assigned groups	
17			
18	Outcomes and	17a For each primary and secondary outcome, results for each group, and the estimated effect size and its	N/A
19	estimation	precision (such as 95% confidence interval)	
20		17b For binary outcomes, presentation of both absolute and relative effect sizes is recommended	N/A
21	Ancillary analyses	18 Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing	N/A
22		pre-specified from exploratory	
23			
24	Harms	19 All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	N/A
25			
26	Discussion		
27	Limitations	20 Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	N/A
28	Generalisability	21 Generalisability (external validity, applicability) of the trial findings	N/A
29	Interpretation	22 Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	N/A
30			
31	Other information		
32	Registration	23 Registration number and name of trial registry	3
33	Protocol	24 Where the full trial protocol can be accessed, if available	3
34	Funding	25 Sources of funding and other support (such as supply of drugs), role of funders	11
35			

36

37 *We strongly recommend reading this statement in conjunction with the CONSORT 2010 Explanation and Elaboration for important clarifications on all the items. If relevant, we also

38 recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological treatments, herbal interventions, and pragmatic trials.

39 Additional extensions are forthcoming: for those and for up to date references relevant to this checklist, see www.consort-statement.org.

40

41

BMJ Open

Study Protocol for the G-SPIRIT trial: A Randomized, Placebo-Controlled, Double-blinded Phase 3 Trial of Granulocyte Colony Stimulating Factor-Mediated Neuroprotection for Acute Spinal Cord Injury

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-019083.R1
Article Type:	Protocol
Date Submitted by the Author:	12-Oct-2017
Complete List of Authors:	<p>Koda, Masao; G-SPIRIT Study Group; University of Tsukuba, Department of Orthopedic Surgery Hanaoka, Hideki; G-SPIRIT Study Group; Chiba University Hospital, Clinical Research Center Sato, Takatoshi; G-SPIRIT Study Group; Chiba University Hospital, Clinical Research Center Fujii, Yasuhisa; G-SPIRIT Study Group; Chiba University Hospital, Clinical Research Center Hanawa, Michiko; G-SPIRIT Study Group; Chiba University Hospital, Clinical Research Center Takahashi, Sho; G-SPIRIT Study Group; Chiba University Hospital, Clinical Research Center Furuya, Takeo; G-SPIRIT Study Group; Graduate School of Medicine, Chiba University, Department of Orthopaedic Surgery Ijima, Yasushi; G-SPIRIT Study Group; Graduate School of Medicine, Chiba University, Department of Orthopaedic Surgery Saito, Junya; G-SPIRIT Study Group; Graduate School of Medicine, Chiba University, Department of Orthopaedic Surgery Kitamura, Mitsuhiro; G-SPIRIT Study Group; Graduate School of Medicine, Chiba University, Department of Orthopaedic Surgery Ohtori, Seiji; G-SPIRIT Study Group; Graduate School of Medicine, Chiba University, Department of Orthopaedic Surgery Matsumoto, Yukei; G-SPIRIT Study Group; University of Tsukuba, Department of Orthopedic Surgery Abe, Tetsuya; G-SPIRIT Study Group; University of Tsukuba, Department of Orthopedic Surgery Watanabe, Kei; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Hirano, Toru; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Ohashi, Masayuki; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Shoji, Hirokazu; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Mizouchi, Tatsuki; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Takahashi, Ikuko; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Kawahara, Norio; G-SPIRIT Study Group; Kanazawa Medical University,</p>

1	
2	
3	
4	Orthopaedic Surgery
5	Kawaguchi, Masahito; G-SPIRIT Study Group; Kanazawa Medical
6	University, Orthopaedic Surgery
7	Orita, Yugo; G-SPIRIT Study Group; Kanazawa Medical University,
8	Orthopaedic Surgery
9	Sasamoto, Takeshi; G-SPIRIT Study Group; Kanazawa Medical University,
10	Orthopaedic Surgery
11	Yoshioka, Masahito; G-SPIRIT Study Group; Kanazawa Medical University,
12	Orthopaedic Surgery
13	Fujii, Masafumi; G-SPIRIT Study Group; Kanazawa Medical University,
14	Orthopaedic Surgery
15	Yonezawa, Katsutaka; G-SPIRIT Study Group; Kanazawa Medical
16	University, Orthopaedic Surgery
17	Soma, Daisuke; G-SPIRIT Study Group; Kanazawa Medical University,
18	Orthopaedic Surgery
19	Taneichi, Hiroshi; G-SPIRIT Study Group; Dokkyo Ika Daigaku, Department
20	of Orthopedic Surgery
21	Takeuchi, Daisaku; G-SPIRIT Study Group; Dokkyo Ika Daigaku,
22	Department of Orthopedic Surgery
23	Inami, Satoshi; G-SPIRIT Study Group; Dokkyo Ika Daigaku, Department
24	of Orthopedic Surgery
25	Moridaira, Hiroshi; G-SPIRIT Study Group; Dokkyo Ika Daigaku,
26	Department of Orthopedic Surgery
27	Ueda, Haruki; G-SPIRIT Study Group; Dokkyo Ika Daigaku, Department of
28	Orthopedic Surgery
29	Asano, Futoshi; G-SPIRIT Study Group; Dokkyo Ika Daigaku, Department
30	of Orthopedic Surgery
31	Shibao, Yosuke; G-SPIRIT Study Group; Dokkyo Ika Daigaku, Department
32	of Orthopedic Surgery
33	Aita, Ikuo; G-SPIRIT Study Group; Tsukuba Medical Center Byoin,
34	Department of Orthopedic Surgery
35	Takeuchi, Yosuke; G-SPIRIT Study Group; Tsukuba Medical Center Byoin,
36	Department of Orthopedic Surgery
37	Mimura, Masaya; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
38	Department of Orthopedic Surgery
39	Shimbo, Jun; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
40	Department of Orthopedic Surgery
41	Someya, Yukio; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
42	Department of Orthopedic Surgery
43	Ikenoue, Sumio; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
44	Department of Orthopedic Surgery
45	Sameda, Hiroaki; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
46	Department of Orthopedic Surgery
47	Takase, Kan; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
48	Department of Orthopedic Surgery
49	Ikeda, Yoshikazu; G-SPIRIT Study Group; Chiba Rosai Byoin, Department
50	of Orthopedic Surgery
51	Nakajima, Fumitake; G-SPIRIT Study Group; Chiba Rosai Byoin,
52	Department of Orthopedic Surgery
53	Hashimoto, Mitsuhiro; G-SPIRIT Study Group; Chiba Rosai Byoin,
54	Department of Orthopedic Surgery
55	Ozawa, Tomoyuki; G-SPIRIT Study Group; Chiba Rosai Byoin, Department
56	of Orthopedic Surgery
57	Hasue, Fumio; G-SPIRIT Study Group; Kimitsu Chuo Byoin, Department of
58	Orthopedic Surgery
59	Fujiyoshi, Takayuki; G-SPIRIT Study Group; Kimitsu Chuo Byoin,
60	Department of Orthopedic Surgery
	Kamiya, Koshiro; G-SPIRIT Study Group; Kimitsu Chuo Byoin, Department
	of Orthopedic Surgery
	Watanabe, Masahiko; G-SPIRIT Study Group; Tokai Daigaku Igakubu
	Seikei Gekagaku, Department of Orthopedic Surgery

1	
2	
3	
4	Katoh, Hiroyuki; G-SPIRIT Study Group; Tokai Daigaku - Isehara Campus,
5	Department of Orthopedic Surgery
6	Matsuyama, Yukihiro; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
7	Department of Orthopedic Surgery
8	Yamato, Yu; G-SPIRIT Study Group; Hamamatsu Ika Daigaku, Department
9	of Orthopedic Surgery
10	Togawa, Daisuke; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
11	Department of Orthopedic Surgery
12	Hasegawa, Tomohiko; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
13	Department of Orthopedic Surgery
14	Kobayashi, Sho; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
15	Department of Orthopedic Surgery
16	Yoshida, Go; G-SPIRIT Study Group; Hamamatsu Ika Daigaku, Department
17	of Orthopedic Surgery
18	Oe, Shin; G-SPIRIT Study Group; Hamamatsu Ika Daigaku, Department of
19	Orthopedic Surgery
20	Banno, Tomohiro; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
21	Department of Orthopedic Surgery
22	Arima, Hideyuki; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
23	Department of Orthopedic Surgery
24	Akeda, Koji; G-SPIRIT Study Group; Mie Daigaku Daigakuin Igakukei
25	Kenkyuka Igakubu, Department of Orthopedic Surgery
26	Kawamoto, Eiji; G-SPIRIT Study Group; Mie Daigaku Daigakuin Igakukei
27	Kenkyuka Igakubu, Department of Orthopedic Surgery
28	Imai, Hiroshi; G-SPIRIT Study Group; Mie Daigaku Daigakuin Igakukei
29	Kenkyuka Igakubu, Department of Orthopedic Surgery
30	Sakakibara, Toshihiko; G-SPIRIT Study Group; Mie Daigaku Daigakuin
31	Igakukei Kenkyuka Igakubu, Department of Orthopedic Surgery
32	Sudo, Akihiro ; G-SPIRIT Study Group; Mie Daigaku Daigakuin Igakukei
33	Kenkyuka Igakubu, Department of Orthopedic Surgery
34	Ito, Yasuo; G-SPIRIT Study Group; Kobe Sekijuji Byoin, Department of
35	Orthopedic Surgery
36	Kikuchi, Tsuyoshi; G-SPIRIT Study Group; Kobe Sekijuji Byoin, Department
37	of Orthopedic Surgery
38	Osaki, Shuhei; G-SPIRIT Study Group; Kobe Sekijuji Byoin, Department of
39	Orthopedic Surgery
40	Tanaka, Nobuhiro; G-SPIRIT Study Group; Hiroshima Daigaku Igakubu
41	Daigakuin Ishiyaku Hokengaku Kenkyuka, Department of Orthopedic
42	Surgery
43	Nakanishi, Kazuyoshi; G-SPIRIT Study Group; Hiroshima Daigaku Igakubu
44	Daigakuin Ishiyaku Hokengaku Kenkyuka, Department of Orthopedic
45	Surgery
46	Kamei, Naosuke; G-SPIRIT Study Group; Hiroshima Daigaku Igakubu
47	Daigakuin Ishiyaku Hokengaku Kenkyuka, Department of Orthopedic
48	Surgery
49	Kotaka, Shinji; G-SPIRIT Study Group; Hiroshima Daigaku Igakubu
50	Daigakuin Ishiyaku Hokengaku Kenkyuka, Department of Orthopedic
51	Surgery
52	Baba, Hideo; G-SPIRIT Study Group; Nagasaki Rosai Byoin, Department of
53	Orthopedic Surgery
54	Okudaira, Tsuyoshi; G-SPIRIT Study Group; Nagasaki Rosai Byoin,
55	Department of Orthopedic Surgery
56	Hiroaki, Konishi; G-SPIRIT Study Group; Nagasaki Rosai Byoin,
57	Department of Orthopedic Surgery
58	Yamaguchi, Takayuki; G-SPIRIT Study Group; Nagasaki Rosai Byoin,
59	Department of Orthopedic Surgery
60	Ito, Keigo; G-SPIRIT Study Group; Chubu Rosai Byoin, Department of
	Orthopedic Surgery
	Katayama, Yoshito; G-SPIRIT Study Group; Chubu Rosai Byoin,
	Department of Orthopedic Surgery
	Matsumoto, Taro; G-SPIRIT Study Group; Chubu Rosai Byoin, Department

	<p>of Orthopedic Surgery Matsumoto, Tomohiro; G-SPIRIT Study Group; Chubu Rosai Byoin, Department of Orthopedic Surgery Idota, Masaru; G-SPIRIT Study Group; Chubu Rosai Byoin, Department of Orthopedic Surgery Kanno, Haruo; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Aizawa, Toshimi; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Hashimoto, Ko; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Eto, Toshimitsu; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Sugaya, Takehiro; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Matsuda, Michiharu; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Fushimi, Kazunari; G-SPIRIT Study Group; Gifu Daigaku Igakubu Daigakuin Igaku Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Nozawa, Satoshi; G-SPIRIT Study Group; Gifu Daigaku Igakubu Daigakuin Igaku Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Iwai, Chizuo; G-SPIRIT Study Group; Gifu Daigaku Igakubu Daigakuin Igaku Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Taguchi, Toshihiko; G-SPIRIT Study Group; Yamaguchi Daigaku Igakubu Daigakuin Igakukei Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Kanchiku, Tsukasa; G-SPIRIT Study Group; Yamaguchi Daigaku Igakubu Daigakuin Igakukei Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Suzuki, Hidenori; G-SPIRIT Study Group; Yamaguchi Daigaku Igakubu Daigakuin Igakukei Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Nishida, Norihiro; G-SPIRIT Study Group; Yamaguchi Daigaku Igakubu Daigakuin Igakukei Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Funaba, Masahiro; G-SPIRIT Study Group; Yamaguchi Daigaku Igakubu Daigakuin Igakukei Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Yamazaki, Masashi; G-SPIRIT Study Group; University of Tsukuba, Department of Orthopedic Surgery</p>
Primary Subject Heading:	Neurology
Secondary Subject Heading:	Medical management
Keywords:	Neurological injury < NEUROLOGY, Spine < ORTHOPAEDIC & TRAUMA SURGERY, Clinical trials < THERAPEUTICS

SCHOLARONE™
 Manuscripts

1
2
3
4
5
6 **Study Protocol for the G-SPIRIT trial: A Randomized, Placebo-Controlled,**
7 **Double-blinded Phase 3 Trial of Granulocyte Colony Stimulating Factor-Mediated**
8 **Neuroprotection for Acute Spinal Cord Injury**
9

10 Corresponding Author: Masao Koda

11 1-1-1 Tennodai, Tsukuba City, Ibaraki 3058575, Japan

12 e-mail: masaokod@gmail.com, tel: 81-29-853-3219
13
14
15

16
17 Authors: Masao Koda^{1,2}, Hideki Hanaoka^{1,3}, Takatoshi Sato^{1,3}, Yasuhisa Fujii^{1,3}, Michiko
18 Hanawa^{1,3}, Sho Takahashi^{1,3}, Takeo Furuya^{1,4}, Yasushi Ijima^{1,4}, Junya Saito^{1,4}, Mitsuhiro
19 Kitamura^{1,4}, Seiji Ohtori^{1,4}, Yukei Matsumoto^{1,2}, Tetsuya Abe^{1,2}, Kei Watanabe^{1,5}, Toru
20 Hirano^{1,5}, Masayuki Ohashi^{1,5}, Hirokazu Shoji^{1,5}, Tatsuki Mizouchi^{1,5}, Ikuko Takahashi^{1,5},
21 Norio Kawahara^{1,6}, Masahito Kawaguchi^{1,6}, Yugo Orita^{1,6}, Takeshi Sasamoto^{1,6}, Masahito
22 Yoshioka^{1,6}, Masafumi Fujii^{1,6}, Katsutaka Yonezawa^{1,6}, Daisuke Soma^{1,6}, Hiroshi
23 Taneichi^{1,7}, Daisaku Takeuchi^{1,7}, Satoshi Inami^{1,7}, Hiroshi Moridaira^{1,7}, Haruki Ueda^{1,7},
24 Futoshi Asano^{1,7}, Yosuke Shibao^{1,7}, Ikuo Aita^{1,8}, Yosuke Takeuchi^{1,8}, Masaya Mimura^{1,9},
25 Jun Shimbo^{1,9}, Yukio Someya^{1,9}, Sumio Ikenoue^{1,9}, Hiroaki Sameda^{1,9}, Kan Takase^{1,9},
26 Yoshikazu Ikeda^{1,10}, Fumitake Nakajima^{1,10}, Mitsuhiro Hashimoto^{1,10}, Tomoyuki Ozawa^{1,10},
27 Fumio Hasue^{1,11}, Takayuki Fujiyoshi^{1,11}, Koshiro Kamiya^{1,11}, Masahiko Watanabe^{1,12},
28 Hiroyuki Katoh^{1,12}, Yukihiro Matsuyama^{1,13}, Yu Yamamoto^{1,13}, Daisuke Togawa^{1,13},
29 Tomohiko Hasegawa^{1,13}, Sho Kobayashi^{1,13}, Go Yoshida^{1,13}, Shin Oe^{1,13}, Tomohiro
30 Banno^{1,13}, Hideyuki Arima^{1,13}, Koji Akeda^{1,14}, Eiji Kawamoto^{1,14}, Hiroshi Imai^{1,14},
31 Toshihiko Sakakibara^{1,14}, Akihiro Sudo^{1,14}, Yasuo Ito^{1,15}, Tsuyoshi Kikuchi^{1,15}, Shuhei
32 Osaki^{1,15}, Nobuhiro Tanaka^{1,16}, Kazuyoshi Nakanishi^{1,16}, Naosuke Kamei^{1,16}, Shinji
33 Kotaka^{1,16}, Hideo Baba^{1,17}, Tsuyoshi Okudaira^{1,17}, Hiroaki Konishi^{1,17}, Takayuki
34 Yamaguchi^{1,17}, Keigo Ito^{1,18}, Yoshito Katayama^{1,18}, Taro Matsumoto^{1,18}, Tomohiro
35 Matsumoto^{1,18}, Masaru Idota^{1,18}, Haruo Kanno^{1,19}, Toshimi Aizawa^{1,19}, Ko Hashimoto^{1,19},
36 Toshimitsu Eto^{1,19}, Takehiro Sugaya^{1,19}, Michiharu Matsuda^{1,19}, Kazunari Fushimi^{1,20},
37 Satoshi Nozawa^{1,20}, Chizuo Iwai^{1,20}, Toshihiko Taguchi^{1,21}, Tsukasa Kanchiku^{1,21}, Hidenori
38 Suzuki^{1,21}, Norihiro Nishida^{1,21}, Masahiro Funaba^{1,21}, Masashi Yamazaki^{1,2}
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5 Affiliations
6

7 ¹G-SPIRIT Study Group is consisted by Nineteen major hospitals in Japan constituting the
8 G-SPIRIT study group
9

10 ²Department of Orthopedic Surgery, University of Tsukuba, Ibaraki

11 ³Clinical Research Center, Chiba University Hospital, Chiba

12 ⁴Department of Orthopedic Surgery, Chiba University Graduate School of Medicine, Chiba

13 ⁵Department of Orthopedic Surgery, Niigata University Graduate School of Medicine and
14 Dental Sciences, Niigata
15

16 ⁶Department of Orthopedic Surgery, Kanazawa Medical University, Ishikawa

17 ⁷Department of Orthopedic Surgery, Dokkyo Medical University, Tochigi

18 ⁸Department of Orthopedic Surgery, Tsukuba Medical Center, Ibaraki

19 ⁹Department of Orthopedic Surgery, Funabashi Municipal Medical Center, Chiba

20 ¹⁰Department of Orthopedic Surgery, Chiba Rosai Hospital, Chiba

21 ¹¹Department of Orthopedic Surgery, Kimitsu Chuo Hospital, Chiba

22 ¹²Department of Orthopedic Surgery, Tokai University School of Medicine, Kanagawa

23 ¹³Department of Orthopedic Surgery, Hamamatsu University School of Medicine, Shizuoka

24 ¹⁴Department of Orthopedic Surgery, Graduate School of Medicine, Mie University, Mie

25 ¹⁵Department of Orthopedic Surgery, Kobe Red Cross Hospital, Hyogo

26 ¹⁶Department of Orthopedic Surgery, Graduate School of Biomedical Sciences, Hiroshima
27 University, Hiroshima
28

29 ¹⁷Department of Orthopedic Surgery, Nagasaki Rosai Hospital, Nagasaki

30 ¹⁸Department of Orthopedic Surgery, Chubu Rosai Hospital, Aichi

31 ¹⁹Department of Orthopedic Surgery, Tohoku University School of Medicine, Miyagi

32 ²⁰Department of Orthopedic Surgery, Gifu University School of Medicine, Gifu

33 ²¹Department of Orthopedic Surgery, Yamaguchi University Graduate School of Medicine,
34 Yamaguchi
35

36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52 Word Count: 2516
53
54
55
56
57

Abstract

Introduction: Granulocyte Colony Stimulating Factor (G-CSF) is generally used for neutropenia. Previous experimental studies revealed that G-CSF promoted neurological recovery after spinal cord injury (SCI). Next we moved to early phase of clinical trials. In a phase 1/2a trial, no adverse events were observed. Next, we conducted a non-randomized, non-blinded, comparative trial, which suggested the efficacy of G-CSF for promoting neurological recovery. Based on those results, we are now performing a phase 3 trial.

Methods and Analysis: The objective of this study is to evaluate the efficacy of G-CSF for acute SCI. The study design is a prospective, multicenter, randomized, double-blinded, placebo-controlled comparative study. The current trial includes cervical SCI (severity of American Spinal Injury Association (ASIA) Impairment Scale B/C) within 48 hours after injury. Patients are randomly assigned to G-CSF and placebo groups. The G-CSF group is administered 400 $\mu\text{g}/\text{m}^2/\text{d}\times 5\text{d}$ of G-CSF in normal saline via intravenous infusion for 5 consecutive days. The placebo group is similarly administered a placebo. Our primary endpoint is changes in ASIA motor scores from baseline to 3 months. Each group includes 44 patients (88 total patients). This trial is funded by the Center for Clinical Trials, Japan Medical Association.

Ethics and Dissemination: The study was approved by the Institutional Review Board of each institution and will be conducted according to the principles of the World Medical Association Declaration of Helsinki and in accordance with the Japanese Medical Research Involving Human Subjects Act and other guidelines, regulations and Acts. Results of the clinical study will be submitted to the head of the respective clinical study site as a report after conclusion of the clinical study by the sponsor-investigator. Even if the results are not favorable despite conducting the clinical study properly, the data will be published as a paper.

Registration: UMIN000018752

<https://upload.umin.ac.jp/cgi-open-bin/ctr/ctr.cgi?function=brows&action=brows&type=summary&recptno=R000021694&language=J>

Strengths and Limitations of This Study

Strengths

- ✓ Novel drug therapy for acute spinal cord injury is much-needed.
- ✓ Randomized, placebo-controlled, double-blinded design can eliminate bias.

Limitations

- ✓ Acute spinal cord injury patients are difficult to recruit to the trial.
- ✓ Patient's neurological status in acute phase is unstable, possibly resulting in dispersion of the patient's background.
- ✓ Concealment must be performed very strictly because G-CSF apparently increases

1
2
3
4
5 white blood cell count.
6

7 **Introduction**

8
9 Spinal cord injury (SCI) is a devastating injury by which the patient can suffer from
10 long-lasting severe sequelae including palsy of extremities, sensory disturbance,
11 bowel/bladder/sexual dysfunction, and neuropathic pain. Conceptually, SCI is divided into
12 two chronological phases: a primary and a secondary phase. Primary injury is mechanical
13 damage to spinal cord tissue itself caused by fracture and/or dislocation or compression.
14 Secondary injury is triggered by the primary injury and is a biological reaction of the spinal
15 cord, which includes ischemia, hemorrhage, excitotoxicity, hyperpermeability, and
16 inflammation¹. Because secondary injury can be the main target of treatment, extensive
17 laboratory and clinical investigation of neuroprotection is needed to manage secondary
18 injury².
19
20
21
22
23
24
25

26 To date, the only approved neuroprotective therapy for SCI is massive
27 methylprednisolone sodium succinate (MPSS) therapy based on the NASCIS 2 study³.
28 However, recent reports revealed that MPSS shows only a modest effect for SCI. In
29 addition, several reports have described adverse events induced by MPSS for SCI including
30 infections (pneumonia, urinary tract infection) and gastrointestinal disorders (gastric ulcer,
31 etc.)⁴. Therefore, the use of MPSS for SCI has become controversial⁵. Accordingly, a new
32 therapeutic drug for SCI is desirable.
33
34
35
36
37

38 Granulocyte colony-stimulating factor (G-CSF, generic name: filgrastim) is a growth
39 factor that affects the hematopoietic system, promoting differentiation, proliferation, and
40 survival of granulocytes⁶. Clinically, in Japan, G-CSF is administered to patients with
41 leukopenia, and to peripheral stem cell transplantation donors, G-CSF is administered to
42 mobilize hematopoietic stem cells into the peripheral blood⁷. In the central nervous system,
43 G-CSF has properties to mobilize the movement of bone marrow cells into the brain⁸ and
44 spine, and in a stroke model, has shown neuroprotective properties⁹. In other countries,
45 clinical studies of the effects of G-CSF in cerebral infarction have been reported¹⁰.
46
47
48
49
50
51

52 To prove the hypothesis that G-CSF has neuroprotective properties against SCI, G-CSF
53 was administered to rat and mouse animal models of spinal cord injury, and hind limb
54
55
56
57

1
2
3
4
5
6 function improved significantly after administration of G-CSF. Further investigations into
7 the mechanism of action of G-CSF in SCI were conducted. Data obtained to date identify
8 the following properties of G-CSF: [1] mobilization of bone marrow-derived stem cells
9 causing their biointegration at the site of SCI¹¹, [2] direct inhibition of nerve cell death¹²,
10 [3] protection of the myelin sheath by inhibiting oligodendrocyte cell death¹³, [4] inhibition
11 of inflammatory cytokine expression (TNF- α , IL-1 β)¹³, and [5] promotion of
12 neovascularization¹⁴. These properties suggest that G-CSF has a neuroprotective effect in
13 acute SCI.
14
15

16
17
18
19 Based on these properties, a phase 1/2a clinical study was conducted where the main
20 objective was to confirm the safety and feasibility of G-CSF for treatment of patients with
21 acute SCI¹⁵. This study was an open-label, dose-titrating study with no control group. As
22 the initial step, 5 patients were given 5 $\mu\text{g}/\text{kg}/\text{day}$ of G-CSF for 5 consecutive days by i.v.
23 infusion, and as the second step, 11 patients were given 10 $\mu\text{g}/\text{kg}/\text{day}$ of G-CSF for 5
24 consecutive days by i.v. infusion. No serious adverse events were noted, and the safety of
25 G-CSF administration in patients with acute SCI was confirmed¹⁵.
26
27
28
29
30

31 As a next step, to validate the efficacy of G-CSF in neuroprotective treatment, a
32 multicenter, prospective, nonrandomized, nonblinded, comparative control study (phase 2b
33 clinical trial) was conducted¹⁶. Based on the results of the previous phase 1/2a clinical trial,
34 the dosage and duration of treatment with G-CSF in this study was 10 $\mu\text{g}/\text{kg}/\text{day}$ for 5
35 consecutive days. Patients with acute cervical SCI (within 48 h of injury) were registered in
36 the clinical trial and allocated to either the G-CSF group (G-CSF 10 $\mu\text{g}/\text{kg}/\text{day} \times 5$ days i.v.
37 infusion) or control group (no G-CSF administration) at each treatment facility. A total of
38 19 patients in the G-CSF group and 26 patients in the control group were observed for 3
39 months or longer. American Spinal Injury Association (ASIA) motor score (motor: 0 to 100
40 points) was compared between the groups. ASIA motor scores were 26.1 ± 18.9 in the
41 G-CSF group and 12.2 ± 14.7 in the control group showing a significant improvement of
42 motor paralysis in the G-CSF group ($p < 0.01$). In addition, in cases that could be followed
43 for 1 year or longer, a significant improvement of ASIA motor score was observed in the
44 G-CSF group¹⁶.
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5 Based on results of these preclinical and early phase clinical trials, we are now
6 conducting a phase 3 trial.
7
8
9

10 *Specific Objective*

11 The objective of this study is to evaluate the efficacy of G-CSF for improving motor
12 paralysis in acute SCI.
13
14
15

16 **Methods and Analysis**

17 *Design of the study*

18 The study design of the current trial is a prospective, multicenter, randomized,
19 double-blinded, placebo-controlled comparative study.
20
21
22
23
24
25

26 *Study Procedures*

27 The study outline is shown in Figure. Patients will be randomly assigned to G-CSF and
28 placebo groups. A central registration system will be used for dynamic randomization into
29 the investigational treatment group (G-CSF) and control group (placebo) based on age at
30 registration (16–64 years of age, or 65–84 years of age) and severity of paralysis (AIS B or
31 C) at 48 h after injury. Initially, screened patients with severity AIS B/C will be tentatively
32 enrolled. Initial screening of the patients include clinical laboratory test, imaging studies
33 including X-ray, magnetic resonance imaging and computed tomography, and
34 neurological/functional evaluations.
35
36
37
38
39
40

41 Neurological re-assessment will be performed 48±4 hours after SCI and the patients
42 who will recover to severity AIS D will be excluded. The patients with severity AIS B/C at
43 neurological re-assessment 48±4 hours after SCI will be enrolled and randomly allocated to
44 either the investigational treatment group (G-CSF) or control group (placebo) in a 1 to 1
45 ratio. The subject registration center uses a program based on an appropriate computer
46 algorithm to allocate patients into groups. The first dose of investigative drugs will be
47 administered to the patients after re-assessment of neurological status and enrollment 48±4
48 hours after SCI.
49
50
51
52
53
54
55
56
57

1
2
3
4
5
6 The G-CSF group will be administered $400 \mu\text{g}/\text{m}^2/\text{d} \times 5\text{d}$ of G-CSF in normal saline via
7 intravenous infusion for 5 consecutive days. The placebo group will be similarly
8 administered a placebo. The first dose of investigative drugs will be administered to the
9 patients 48 ± 4 hours after SCI. The dosing schedule will be once a day in every morning
10 (9-10 AM) for consecutive 5 days even in case that the first dosing was performed at night
11 because of restriction on practices. Investigational drugs including both G-CSF and placebo
12 will be stored in refrigerator which will be kept between $1-6^\circ\text{C}$ and has temperature-logger
13 in pharmacies in each participating institutes. The investigational drugs is packaged in
14 ample with label only printed as serial numbers, ten ample is packed in one box with label
15 only printed serial numbers. Web-based allocation system will show the serial number of
16 investigational drug which must be used to respective patients to ensure blinding.
17
18
19
20
21
22
23

24 We decided dosage of drug based on our previous non-randomized early phase clinical
25 studies. On phase 1/2a clinical study, of which study design was open-label, dose-titrating
26 study with no control group, SCI patients who were administered $10 \mu\text{g}/\text{kg}/\text{day}$ G-CSF
27 for 5 days showed marked elevation of white blood cell number (reached nearly $50000/\mu\text{l}$,
28 of which WBC number might cause adverse effects of G-CSF) during G-CSF
29 administration¹⁵. Therefore we decided to withdraw additional titration. In addition, next
30 phase of clinical study, of which design was multicenter, prospective, nonrandomized,
31 nonblinded, comparative control study, showed suggestive efficacy of G-CSF ($10 \mu\text{g}/\text{kg}/\text{d}$
32 for 5 days) for acute SCI¹⁶. Based on those results, we finally decided the dosage of G-CSF
33 as $10 \mu\text{g}/\text{kg}/\text{d} \times 5\text{d}$ for 5 days. In the current clinical trial, the dosage of G-CSF is written as
34 $400 \mu\text{g}/\text{m}^2/\text{d}$ ($= 10 \mu\text{g}/\text{kg}/\text{d}$) according to the Japanese Pharmaceutical and Medical Device
35 Agency (PMDA)'s instruction for consolidation with product labeling.
36
37
38
39
40
41
42
43
44
45

46 We decided to 48hours after SCI as the therapeutic time window because our previous
47 multicenter, prospective, nonrandomized, nonblinded, comparative control study, which
48 recruited SCI patients within 48 hours after injury, showed that there was no significant
49 difference in neurological outcome between the patient administered G-CSF very early
50 after the injury and 48 hours after injury¹⁶.
51
52
53

54 Allocation will be concealed between blinded evaluators of efficacy/safety and those
55
56
57

1
2
3
4
5 for laboratory data, as G-CSF markedly increases white blood cell counts that can reveal
6 patient treatment.
7

8
9 Our primary endpoint is changes in ASIA motor scores (international standards for
10 neurological classification of spinal cord injury (ISNSCI) suppl. Figure 1) from baseline to
11 3 months calculated as follows: 3-month ASIA motor score change = 3-month ASIA motor
12 score – pretreatment ASIA motor score. To maintain consistency of neurological
13 assessment among the each evaluators, attending lecture and e-learning (in website of
14 International Spinal Cord Society: <http://www.elearnsoci.org/>) of ASIA/ISNSCI scoring
15 system is mandatory for every investigators participating to the present trial.
16
17
18
19
20

21 Secondary endpoints are as follows. [1] Change in ASIA motor scores at 6 months and
22 12 months after G-CSF administration compared with pretreatment. [2] Changes in sensory
23 paralysis over time: change in ASIA sensory scores at 3 months, 6 months, and 12 months
24 after G-CSF administration compared with pretreatment. [3] Severity of functional
25 compromise because of paralysis: AIS before administration and at 3, 6, and 12 months
26 after administration of G-CSF. [4] Percentage of responders: percentage of patients whose
27 AIS improved by 1 grade or more at 3, 6, and 12 months after administration compared
28 with before administration of G-CSF. [5] Neurological level of injury (NLI): percentage of
29 patients whose NLI decreased by 1 grade or more at 3, 6, or 12 months after administration
30 of G-CSF compared with pretreatment. [6] SCIM: change in SCIM scores at 3, 6, and 12
31 months after G-CSF administration compared with pretreatment [7] EQ-5D: measured
32 EQ-5D efficacy scores at 3, 6, and 12 months after G-CSF.
33
34
35
36
37
38
39
40
41

42 To strengthen the analysis, more strict blindness of assessment by the evaluator for
43 outcome measures is ideal. Therefore every prior score/measurement should be blinded
44 and/or not the same person should assess every midpoint motor/sensory functional
45 measurement. However, PMDA instructed us to assess one patients' functional evaluation
46 by one evaluator for consistent assessment in respective patients. PMDA considers the
47 consistency of assessment in respective patients is more important.
48
49
50
51

52 The precise explanation of abovementioned outcome measures is as followings (suppl.
53 Figures). ASIA motor score is determined by examining a key muscle function within each
54
55
56
57
58
59
60

1
2
3
4
5 of 10 myotomes on each side of the body on manual muscle testing (MMT) in the supine
6 position. There is a range of score from 0 to 25 for each extremity, totaling 0 to 50 for the
7 upper limbs and 0 to 50 for the lower limbs, resulting in total of ASIA motor score ranges
8 from 0 to 100. This score can reflect the degree of motor impairment associated with the
9 SCI (suppl. Figure 1). ASIA sensory scores is completed through the testing of a key point
10 in each of the 28 dermatomes (from C2 to S4-5) on the right and left sides of the body that
11 can be readily located in relation to bony anatomical landmarks. At each of these key points,
12 two aspects of sensation are examined: light touch and pin prick. Appreciation of light
13 touch and pin prick sensation at each of the key points is separately scored on a three-point
14 scale, with comparison to the sensation on the patients' cheek as a normal frame of
15 reference: 0 = absent, 1 = altered, 2 = normal or intact. As a result, ASIA sensory scores
16 range from 0 to 112 (suppl. Figure 1). AIS designation is used in grading the degree of
17 impairment: A = Complete. No sensory or motor function is preserved in the sacral
18 segments S4-S5. B = Sensory incomplete. Sensory but not motor function is preserved
19 below the neurological level. C = Motor incomplete. Motor function is preserved below the
20 neurological level, and more than half of key muscle functions below the single
21 neurological level of injury have a muscle grade less than 3 (Grades 0–2). D = Motor
22 incomplete. Motor function is preserved below the neurological level, and at least half (half
23 or more) of key muscle functions below the neurological level have a muscle grade >3.
24 E = Normal. If sensation and motor function as tested are graded as normal in all segments,
25 and the patient had prior deficits, then the AIS grade is E (suppl. Figure 1, footnote). NLI
26 refers to the most caudal segment of the cord with intact sensation and antigravity muscle
27 function strength, provided that there is normal (intact) sensory and motor function rostrally
28 (suppl. Figure 1, footnote). SCIM is disability scale developed specifically for patients with
29 spinal cord lesions in order to make the functional assessments of patients with paraplegia
30 or tetraplegia more sensitive to changes. The SCIM includes the following areas of
31 function: self-care (subscore (0-20), respiration and sphincter management (0-40) and
32 mobility (0-40). Each area is scored according to its proportional weight in these patients'
33 general activity. The final score ranges from 0 to 100 (suppl. Figure 2-4). EQ-5D
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5 essentially consists of 2 pages (suppl. Figure 5, 6): the EQ-5D descriptive system and the
6 EQ visual analogue scale (EQ VAS). The descriptive system comprises five dimensions:
7 mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Each
8 dimension has 5 levels: no problems, slight problems, moderate problems, severe problems
9 and extreme problems. The patient is asked to indicate his/her health state by ticking the
10 box next to the most appropriate statement in each of the five dimensions. This decision
11 results in a 1-digit number that expresses the level selected for that dimension. The digits
12 for the five dimensions can be combined into a 5-digit number that describes the patient's
13 health state and can be converted to efficacy score with calibration scale (ranges -0.111 to
14 1.000). The EQ VAS records the patient's self-rated health on a vertical visual analogue
15 scale, where the endpoints are labelled 'The best health you can imagine' and 'The worst
16 health you can imagine'. The VAS can be used as a quantitative measure of health outcome
17 that reflect the patient's own judgement.
18
19
20
21
22
23
24
25
26
27
28

29 Each group will include 44 patients (88 patients in total). Our protocol was approved by
30 PMDA and this trial will be funded by the Center for Clinical Trials, Japan Medical
31 Association.
32
33
34
35
36

37 *Inclusion*

38
39 Inclusion criteria are as follows. [1] Patients with cervical SCI (severity of AIS B/C)
40 within 48 h of injury. [2] Patients reassessed for neurological status at 48 h after injury, and
41 those whose palsy is AIS B/C will be enrolled. [3] Patients with neurological level of injury
42 between C4 and C7. [4] Patients with age of 16 to 85 years. [5] Patients who agree to
43 participate in the current trial and from whom informed consent was obtained orally and in
44 writing. [6] Patients who can be followed up for 12 months after SCI.
45
46
47
48
49
50

51 *Exclusion*

52
53 Exclusion criteria are as follows. [1] Patients with neurological recovery to AIS D at
54 neurological reassessment 48 h after SCI, because only AIS B/C patients will be included to
55
56
57

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

standardize the severity of paresis in order to stratify the patients at the initiation of drug administration. [2] Allergy to G-CSF. [3] Hematological malignancy, [4] within 6 months after invasive coronary intervention, [5] splenomegaly, or [6] pregnancy, [7] consciousness impairment, [8] neurological disorders that can affect neurological evaluation in the present trial, [9] fracture of extremities that can affect the neurological evaluation and [10] massive dose administration of MPSS. Exclusion criteria 2 - 6 are set for safety, criteria 1, 7 - 9 are set to maintain homogeneity of the patient population enrolled, criteria 7-9 are set for maintenance of accuracy of functional assessment, criteria 7 is set to obtain patients' own informed consent upon participation to the trial and criteria 10 is set to omit the possible interference of MPSS on outcome assessment.

Concealment

Patients will be administered drug or placebo and be evaluated in a double-blinded manner. An evaluator blinded to the treatment will take charge of patient evaluation including clinical findings and paresis, without laboratory data because G-CSF induces an apparent increase of white blood cell count that makes it easy to distinguish G-CSF and placebo treatment. Therefore, a non-blinded evaluator for laboratory data will be assigned to evaluate laboratory data alone. From a safety point-of view, the dose of G-CSF will be modulated according to excessive increase of white blood cell count. Therefore, a non-blinded evaluator will instruct the pharmacy to modulate the dose of G-CSF based on white blood cell count.

Sample Size Calculation

The target sample size for this randomized trial is 88. This number is based on the results of previous clinical trials¹⁶. The estimated group difference (\pm standard deviation) of change in ASIA motor scores from baseline to 3 months is 13.9 (\pm 21.9). A sample size of 44 patients in each group will provide 80% power to detect a difference of the change in ASIA motor scores between the G-CSF and the placebo treatments, using a mixed-effects models for repeated measures (MMRM) at a two-sided 5% level of significance. A

1
2
3
4
5 common correlation of 0.25 at each time point is assumed. A dropout rate of 10% is
6 allowed. Thus, the total sample size of 88 patients is required for the trial.
7
8
9

10 *Statistical analyses*

11
12 The analyses of the primary and secondary end points will be performed as
13 intention-to-treat analyses in a full analysis set, which includes all patients who: (1) took at
14 least one course of treatment during the study; (2) do not present any serious violation of
15 the study protocol; and (3) have data collected after commencement of treatment. For the
16 baseline characteristics, summary statistics will comprise frequencies and proportions for
17 categorical variables, and means and SDs for continuous variables. The patient
18 characteristics will be compared using a chi-square test for categorical variables, and a *t* test
19 or Wilcoxon rank sum test for continuous variables. Missing data including loss to
20 follow-up and missing measurement will be supplemented with MMRM.
21
22
23
24
25
26
27

28 For the primary analysis, aimed at comparing treatment effects, a change in ASIA motor
29 score from baseline to 3 months and its 95% confidence interval (CI) will be estimated
30 using the MMRM. To test for significant association of the primary endpoint, a mixed
31 effects model for repeated measures with an unstructured covariance matrix will be applied
32 to adjust for age (<65 years or ≥65 years) and AIS at 48 h after the injury (B or C).
33
34
35
36

37 For the secondary analysis, the change in ASIA motor score will be compared using a
38 Student *t* test and the 95% CI will be estimated. The same method will be applied to change
39 in sensory score, SCIM, and EQ-5D. A chi-squared test will be applied to the frequencies of
40 the responder in AIS and of the improvement in NLI. The frequency of AIS will be
41 summarized. The frequency of AEs will be compared using a Fisher exact test.
42
43
44

45 All comparisons are planned and all *p* values will be two sided. $p < 0.05$ will be
46 considered significant. All statistical analyses will be performed using SAS software
47 (version 9.4; SAS Institute, Cary, NC, USA). The statistical analysis plan will be developed
48 by the principal investigator and the biostatistician before completion of patient recruitment
49 and fixing of data.
50
51
52
53
54
55
56
57

Data Monitoring Committee

The data monitoring committee consists of three clinical trial specialists, including a biostatistician, who are independent from the current study. The committee will meet at least 2 times per year and all the data obtained by the current trial will be checked by the committee.

Adverse Events

As for safety evaluation, adverse events will be collected as follows. “Adverse events” refers to any untoward symptom or disease or signs of such (including clinical laboratory data abnormalities) in a clinical investigation subject after informed consent and does not necessarily have a causal relationship with the investigational product (G-CSF).

Increases in white blood counts will be considered an adverse event only when the count exceeds 50,000/ μL from the perspective of a pharmacological effect of G-CSF, and any values below this will not be handled as an adverse event. Anaphylaxis and adult respiratory distress syndrome are the most representative G-CSF-related severe adverse events to be paid full attention.

All adverse events will code terminology used by the investigators according to the ICH International Medical Dictionary for Regulatory Activities Japanese version (MedDRA/J).

Ethics and Dissemination

Ethics

The study was approved by the Institutional Review Board (IRB) of each institutions involved to the present trial and will be conducted according to the principles of the World Medical Association (WMA) Declaration of Helsinki—Ethical Principles for Medical Research Involving Human Subjects with the amendments made in Seoul, South Korea, October 2008, with a Note of Clarification on Paragraph 29 added by the WMA General Assembly, Washington 2002; Note of Clarification on Paragraph 30 added by the WMA General Assembly, Tokyo 2004, and in accordance with the Japanese Medical Research Involving Human Subjects Act (WMO) and other guidelines, regulations and Acts.

Patient informed consent

The principal investigator will try to prepare the informed consent form and other explanatory materials in as simple language as possible in order to obtain informed consent from the patient and the patient's legal representative. In case that trial participants cannot sign the informed consent form due to upper extremity palsy caused by SCI, allograph by patients' representative will be allowed.

Public Disclosure and Publication Policy

Results of the clinical study will be submitted to the head of the respective clinical study site as a report after conclusion of the clinical study by the sponsor-investigator (includes study coordinating investigator). Even if the results are not favorable despite conducting the clinical study properly, the data will be published as a paper. Other sponsor-investigators (including the clinical study coordinating investigator), if they plan to publicize the data from this study in a specialized academic society conference or other external site, must first obtain permission from the other principal investigators and investigational product provider. In publicizing the results, the confidentiality of the subjects will be maintained and proofread in advance by the other sponsor-investigators (includes coordinating investigator) and investigational product provider.

Discussion

The current trial is a confirmative trial to elucidate the therapeutic efficacy of G-CSF for SCI. If the current trial can successfully show significant improvement of motor paralysis of SCI by G-CSF, we will move forward to drug approval application to the Ministry for Health and Labor, Japan. The entire protocol of the current trial was approved beforehand for the initiation of the current trial by the Japanese Pharmaceutical and Medical Device Agency (PMDA). The PMDA will also permit a drug approval application if significant efficacy of G-CSF for SCI is proven.

The current trial is an important milestone for SCI clinics and research to explore

1
2
3
4
5 G-CSF for SCI.
6
7

8
9 *Trial Status*

10 The present trial is now on-going.

11
12 *Trial Sites*

13
14 Nineteen major hospitals in Japan constituting the G-SPIRIT study group as follows:
15 Tohoku University Hospital, Miyagi; Niigata University, Niigata; Dokkyo University
16 Hospital, Tochigi; Tsukuba University Hospital, Ibaraki; Tsukuba Medical Center, Ibaraki;
17 Chiba University Hospital, Chiba; Funabashi Municipal Medical Center, Chiba; Kimitsu
18 Chuo Hospital, Chiba; Chiba Rosai Hospital, Chiba; Tokai University Hospital, Kanagawa;
19 Hamamatsu University Hospital, Shizuoka; Gifu University Hospital, Gifu; Chubu Rosai
20 Hospital, Aichi; Mie University Hospital, Mie; Kanazawa Medical Collage, Ishikawa;
21 Kobe Red Cross Hospital, Hyogo; Hiroshima University Hospital, Hiroshima; Yamaguchi
22 University Hospital, Yamaguchi; and Nagasaki Rosai Hospital, Nagasaki.
23
24
25
26
27
28
29
30

31 **Funding Statement**

32 This trial is supported by Center for Clinical trials, Japan Medical Association, Japan.
33
34

35 **Competing Interests**

36 No authors have any competing interests to declare.
37
38
39

40 **Contributorship Statement**

41 MK, TF and MY contributed to planning and conduct of the present trial and to reporting
42 the present protocol paper. HH, TS, YF, MH and ST contributed to conception and design
43 of the present trial protocol and to reporting the present protocol paper. YI, JS, MK, SO,
44 YM, TA, KW, TH, MO, HS, TM, IT, NK, MK. YO, TS, MY, MF, KY, DS, HT, DT, SI,
45 HM, HU, FA, YS, IA, YT, MM, JS, YS, SI, HS, KT, YI, FN, MH, TO, FH, TF, KK, MW,
46 HK, YM, YY, DT, TH, SK, GY, SO, TB, HA, KA, EK, HI, TS, AS, YI, TK, SO, NT, KN,
47 NK, SK, HB, TO, HK, TY, IK, KY, TM, TM, IM, HK, TA, KH, TE, TS, MM, KF, SN, CI,
48 TT, TK, HS, NN and MF contributed to conducting the present trial and to acquisition of
49
50
51
52
53
54
55
56
57

1
2
3
4
5 data.
6
7
8

9 References

- 10 1. Oyinbo CA. Secondary injury mechanisms in traumatic spinal cord injury: a nugget
11 of multiply cascade. *Acta Neurobiol Exp* 2011;71:281-299.
- 12 2. Karsy M, Hawryluk G. Pharmacologic Management of Acute Spinal Cord Injury.
13 *Neurosurg Clin N Am* 2017;28:49-62. doi: 10.1016/j.nec.2016.07.002.
- 14 3. Bracken MB, Shepard MJ, Collins WF, et al. A randomized controlled trial of
15 methylprednisolone or naloxone in the treatment of acute spinal cord injury: results
16 of the second national acute spinal cord injury study. *N Engl J Med* 1990;322:
17 1405-1411.
- 18 4. Matsumoto T, Tamaki T, Kawakami M, et al. Early complications of high-dose
19 methyl-prednisolone sodium succinate treatment in the follow-up of acute cervical
20 spinal cord injury. *Spine* 2001;26: 426-430.
- 21 5. Hurlbert RJ, Hadley, Walters BC, et al. Pharmacological Therapy for Acute Spinal
22 cord Injury. *Neurosurgery* 2013;72: 93-105.
- 23 6. Nicola NA, Metcalf D, Matsumoto M, Johnson GR. Purification of a factor inducing
24 differentiation in murine myelomonocytic leukemia cells. Identification as
25 granulocyte colony-stimulating factor. *J Biol Chem* 1983;258: 9017-9023.
- 26 7. Roberts AW: G-CSF: a key regulator of neutrophil production, but that's no all!
27 *Growth Factors* 2005;23: 33-41.
- 28 8. Kawada H, Takizawa S, Takanashi T, et al. Administration of hematopoietic
29 cytokines in the subacute phase after cerebral infarction is effective for functional
30 recovery facilitating proliferation of intrinsic neural stem/progenitor cells and
31 transition of bone marrow-derived neuronal cells. *Circulation* 2006;113: 701-710.
- 32 9. Schneider A, Kruger C, Steigleder T, et al. The hematopoietic factor G-CSF is a
33 neuronal ligand that counteracts programmed cell death and drives neurogenesis. *J*
34 *Clin Invest* 2005;115: 2083-2098.
- 35 10. Shyu WC, Lin SZ, Lee CC, Liu DD, Li H. Granulocyte colony-stimulating factor
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

16

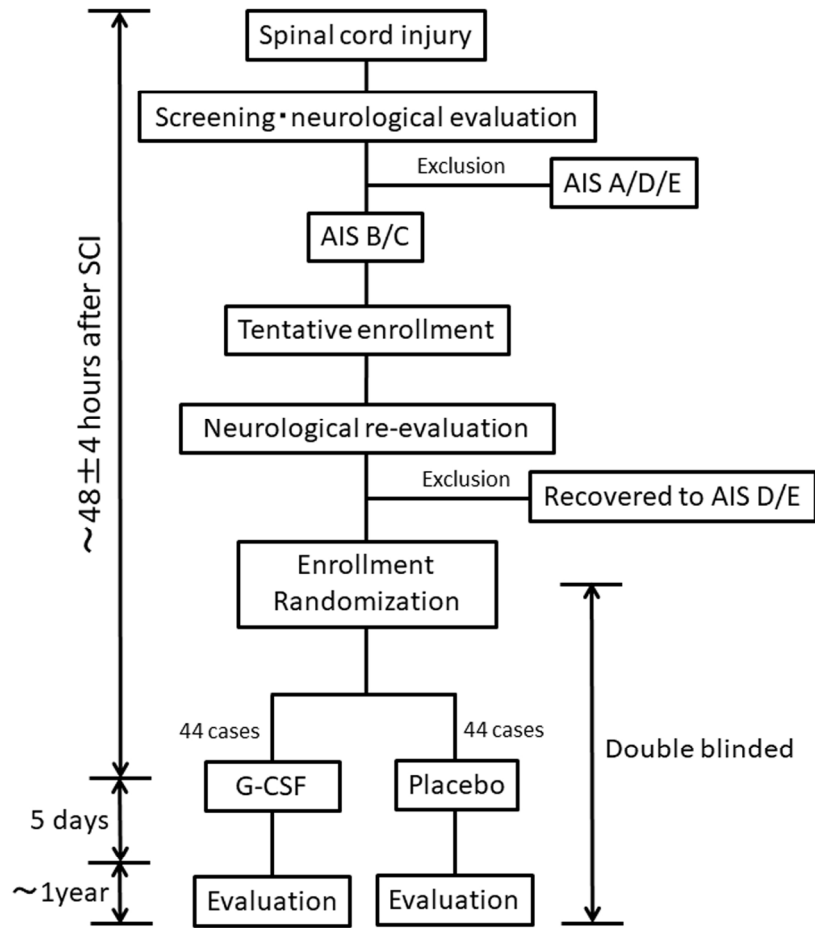
- 1
2
3
4
5
6 for acute ischemic stroke: a randomized controlled trial. *CMAJ* 2006;174: 927-933.
- 7
8 11. Koda M, Nishio Y, Kamada T, et al. Granulocyte colony-stimulating factor
9 (G-CSF) mobilizes bone marrow-derived cells into injured spinal cord and
10 promotes functional recovery after compression-induced spinal cord injury in mice.
11 *Brain Res* 2007;1149: 223-231.
- 12
13
14 12. Nishio Y, Koda M, Kamada T, et al. Granulocyte colony-stimulating factor
15 (G-CSF) attenuates neuronal death and promotes functional recovery after spinal
16 cord injury in mice. *J Neuropathol Exp Neurol* 2007;66: 724-731.
- 17
18
19 13. Kadota R, Koda M, Kawabe J, et al. Granulocyte colony-stimulating factor (G-CSF)
20 protects oligodendrocyte and promotes hindlimb functional recovery after spinal cord
21 injury in rats. *PLoS One* 2012;7:e50391.
- 22
23
24 14. Kawabe J, Koda M, Hashimoto M, et al. Granulocyte colony-stimulating factor
25 (G-CSF) exerts neuroprotective effects via promoting angiogenesis after spinal cord
26 injury in rats. *J Neurosurg Spine* 2011;15: 414-421.
- 27
28
29 15. Takahashi H, Yamazaki M, Okawa A, et al. Neuroprotective therapy using
30 granulocyte colony-stimulating factor for acute spinal cord injury: a phase I/IIa
31 clinical trial. *Eur Spine J* 2012;21:2580-2587.
- 32
33
34 16. Inada T, Takahashi H, Yamazaki M, et al. A multicenter prospective
35 non-randomized controlled clinical trial to prove neurotherapeutic effects of
36 granulocyte colony-stimulating factor (G-CSF) for acute spinal cord injury:
37 Analyses of follow-up cases after at least one year. *Spine* 2014;39:213-219.
- 38
39
40
41
42
43

44 Figure legend

45 Schematic diagram showing trial timeline.

46
47
48
49
50
51
52
53
54
55
56
57

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



Schematic diagram showing trial timeline.

190x254mm (300 x 300 DPI)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY (ISNCSCI)

ASIA AMERICAN SPINAL INJURY ASSOCIATION **ISCOS** INTERNATIONAL STANDARDS FOR SPINAL CORD INJURY

Patient Name _____ Date/Time of Exam _____
 Examiner Name _____ Signature _____

RIGHT

MOTOR KEY MUSCLES

Elbow flexors C5
 Wrist extensors C6
 Elbow extensors C7
 Finger flexors C8
 Finger abductors (little finger) T1

NER (Upper Extremity Right)

LER (Lower Extremity Right)

Hip flexors L2
 Knee extensors L3
 Ankle dorsiflexors L4
 Long toe extensors L5
 Ankle plantar flexors S1

(VAC) Voluntary anal contraction (Yes/No)

RIGHT TOTALS (MAXIMUM) (50) (56) (56)

Key Sensory Points

SENSORY KEY SENSORY POINTS

Light Touch (LTR) Pin Prick (PPR)

C2
C3
C4
C5
C6
C7
C8
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
L1
L2
L3
L4
L5
S1
S2
S3
S4-5

SENSORY SUBSCORES

LTR + LTL = LT TOTAL (MAX (56) (56))

PPR + PPL = PP TOTAL (MAX (56) (56))

LEFT

MOTOR KEY MUSCLES

Elbow flexors C5
 Wrist extensors C6
 Elbow extensors C7
 Finger flexors C8
 Finger abductors (little finger) T1

NER (Upper Extremity Left)

LER (Lower Extremity Left)

Hip flexors L2
 Knee extensors L3
 Ankle dorsiflexors L4
 Long toe extensors L5
 Ankle plantar flexors S1

(DAP) Deep anal pressure (Yes/No)

LEFT TOTALS (MAXIMUM) (50) (56) (56)

MOTOR SUBSCORES

NER + NEL = NEMS TOTAL (MAX (25) (25))

LER + LEL = LEMS TOTAL (MAX (25) (25))

SENSORY SUBSCORES

LTR + LTL = LT TOTAL (MAX (56) (56))

PPR + PPL = PP TOTAL (MAX (56) (56))

NEUROLOGICAL LEVELS

1. SENSORY R L

2. MOTOR R L

3. NEUROLOGICAL LEVEL OF INJURY (NLI)

4. COMPLETE OR INCOMPLETE?

5. ASIA IMPAIRMENT SCALE (AIS)

ZONE OF PARTIAL PRESERVATION (Most caudal level with any innervation)

SENSORY R L

MOTOR R L

274x206mm (300 x 300 DPI)

セルフケア

- (1) 食事（切る、容器を開ける、飲み物を注ぐ、食べ物を口に運ぶ、飲み物の入ったコップをもつ）
0. 静脈栄養または胃瘻が必要である、あるいは経口摂取において全介助を要する。
 1. 食べたり飲んだりすること、または補助器具の装着に部分介助を要する。
 2. 食べることは自立、補助器具を必要とするか、または食べ物を切ったり注いだりすること、容器の開閉にのみ解介助を要する。
 3. 食べることも飲むことも自立、介助や補助器具を必要としない。
- (2) 入浴（頭と体を石鹸でこすって洗い、乾かす、蛇口の開け閉め） A—上半身、B—下半身
- A.
0. 全介助を要する。
 1. 部分介助を要する。
 2. 補助器具、または特定の環境（例えば、手すりや椅子）が整っていれば、自立して体を洗う。
 3. 自立して体を洗う。（通常、健常者なら用いることのない）補助器具や特定の環境設定は不要
- B.
0. 全介助を要する。
 1. 部分介助を要する。
 2. 補助器具、または特定の環境が整っていれば、自立して体を洗う。
 3. 自立して体を洗う、補助器具や特定の環境設定は不要
- (3) 更衣（衣服、靴、常用している装具の着脱） A—上半身、B—下半身
- A.
0. 全介助を要する。
 1. ボタン、ファスナー、ひものない衣服で部分介助を要する。
 2. ボタン、ファスナー、ひものない衣服であれば自立、補助器具と特定の環境設定、またはそのどちらかが必要。
 3. ボタン、ファスナー、ひものない衣服であれば自立、補助器具も特定の環境設定も不要、ボタン、ファスナー、ひもの扱いにだけ介助、補助器具、または特定の環境設定が必要。
 - 4.（衣類の種類を問わず）自立して着替える、補助器具も特定の環境設定も不要。
- B.
0. 全介助を要する。
 1. ボタン、ファスナー、ひものない衣服で部分介助を要する。
 2. ボタン、ファスナー、ひものない衣服であれば自立、補助器具と特定の環境設定、またはそのどちらかが必要。
 3. ボタン、ファスナー、ひものない衣服であれば自立、補助器具も特定の環境設定も不要、ボタン、ファスナー、ひもの扱いにだけ介助、補助器具、または特定の環境設定が必要。
 - 4.（衣類の種類を問わず）自立して着替える、補助器具も特定の環境設定も不要。
- (4) 整容（手洗い、洗顔、歯磨き、整髪、髭剃り、化粧）
0. 全介助を要する。
 1. 部分介助を要する。
 2. 補助器具があれば自立して整容動作をおこなう。
 3. 補助器具を用いずに自立して整容動作をおこなう。

小計 (0-20)

呼吸と排泄管理

- (5) 呼吸
0. 気管チューブと持続的補助換気または間欠的補助換気が必要。
 2. 気管チューブを装着して自己呼吸、酸素を必要としたり、咳嗽時または気管チューブの管理に多大な介助を必要とする。
 4. 気管チューブを装着して自己呼吸、咳嗽時または気管チューブの管理に少ししか介助を必要としない。
 6. 気管チューブなしで自己呼吸、酸素、咳嗽時の多大な介助、マスク（例：終末呼吸陽圧 PEEP）、または間欠的補助換気 (BiPAP) を必要とする。
 8. 気管チューブなしで自己呼吸、介助または咳嗽刺激を少ししか必要としない。
 10. 介助も器具もなしで自己呼吸。

190x254mm (300 x 300 DPI)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

- (6) 排尿管理
 - 0. 留置カテーテル
 - 3. 残尿量 > 100cc. 不定期導尿または介助による間欠的導尿.
 - 6. 残尿量 > 100cc または間欠的の自己導尿. 集尿器¹をあてがう際の介助は必要.
 - 9. 間欠的の自己導尿. 集尿器を使用する. 器具をあてがう際の介助は不要.
 - 11. 間欠的の自己導尿. 導尿と導尿の間には失禁なし. 集尿器は使用しない.
 - 13. 残尿量 < 100cc. 集尿器のみ必要. 集尿器の取扱いには介助不要.
 - 15. 残尿量 < 100cc. 失禁なし. 集尿器を使用しない.

- (7) 排便管理
 - 0. 排便が不規則またはごく低頻度 (3 日に 1 回未満).
 - 5. 規則的ながら. (座薬を挿入するなど)に介助を要する. 失敗はまれ (月 2 回未満).
 - 8. 規則的な排便で. 介助を要しない. 失敗はまれ (月 2 回未満).
 - 10. 規則的な排便で. 介助を要しない. 失敗はなし.

- (8) トイレの使用 (会陰部の清潔. 使用前後での衣服の扱い. ナプキンまたはおむつの使用)
 - 0. 全介助を要する.
 - 1. 部分介助を要する. 自分でお尻を拭けない.
 - 2. 部分介助を要する. 自立してお尻を拭ける.
 - 4. 自立してトイレを使用するも. 補助器具または特別な環境 (例: 手すり) が整っている必要あり.
 - 5. 自立してトイレを使用. 補助器具も特別な環境が整っている必要もない.

- 小計 (0-40)

- 移動 (室内とトイレ)**
- (9) ベッド上での姿勢変換と褥瘡予防動作
 - 0. ベッド上で上半身の向きを変えること. 下半身の向きを変えること. 起き上がること. および車椅子上で
のプッシュアップのすべての動作に介助が必要. 補助器具の要否は問わないが. 電動器具は用いない.
 - 2. 介助なくできる動作が 1 つある.
 - 4. 介助なくできる動作が 2 つまたは 3 つある.
 - 6. ベッド上動作と除圧動作はすべて自立しておこなう.

- (10) 移乗: ベッド-車椅子 (車いすのブレーキ操作. フットレストの跳ね上げ. アームレストの脱着. 乗り移り. 足の持ち上げ)
 - 0. 全介助を要する.
 - 1. 部分介助. 監視. および補助器具 (例: スライディングボード) のすべて. もしくは. そのいずれかが必要.
 - 2. 自立 (または車椅子を必要としない).

- (11) 移乗: 車椅子-トイレ. 浴槽 (トイレ用車椅子¹ を使用している場合は. それへのからの乗り移り. 通常の車椅子を使用している場合は. 車椅子のブレーキ操作. フットレストの跳ね上げ. アームレストの脱着. 乗り移り. 足の持ち上げ)
 - 0. 全介助を要する.
 - 1. 部分介助. 監視. および補助器具 (例: 手すり) のすべて. もしくは. そのいずれかが必要.
 - 2. 自立 (または車椅子を必要としない).

- 移動 (屋内と屋外. 平らな所で)**
- (12) 屋内の移動
 - 0. 全介助を要する.
 - 1. 電動車椅子を必要とするか. または手動車椅子を操作するのに部分介助を要する.
 - 2. 手動車椅子で自立して移動する.
 - 3. 歩行時に監視を必要とする (器具の要否は問わない).
 - 4. 歩行器または松葉杖で歩行 (大振り・小振り歩行).
 - 5. 松葉杖または T 字杖 2 本で歩行 (交互歩行).
 - 6. T 字杖 1 本で歩行.
 - 7. 下肢装具のみを必要とする.
 - 8. 歩行補助具なしで歩行.

190x254mm (300 x 300 DPI)

- 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
- (13) まとまった距離の移動 (10~100m)
0. 全介助を要する。
 1. 電動車椅子を必要とするか、または手動車椅子を操作するのに部分介助を要する。
 2. 手動車椅子で自立して移動する。
 3. 歩行時に監視を必要とする(器具の要否は問わない)。
 4. 歩行器または松葉杖で歩行(大振り・小振り歩行)。
 5. 松葉杖または T 字杖 2 本で歩行(交互歩行)。
 6. T 字杖 1 本で歩行。
 7. 下肢装具のみを必要とする。
 8. 歩行補助具なしで歩行。
- (14) 屋外の移動 (100m 以上)
0. 全介助を要する。
 1. 電動車椅子を使用するか、または手動車椅子を操作するのに部分介助を要する。
 2. 手動車椅子で自立して移動する。
 3. 歩行時に監視を必要とする(器具の要否は問わない)。
 4. 歩行器または松葉杖で歩行(大振り・小振り歩行)。
 5. 松葉杖または T 字杖 2 本で歩行(交互歩行)。
 6. T 字杖 1 本で歩行。
 7. 下肢装具のみを必要とする。
 8. 歩行補助具なしで歩行。
- (15) 階段昇降
0. 階段の上り下り不能。
 1. 人に支えられるか、またはその監視下で少なくとも 3 段は上り下りできる。
 2. 手すりにつかまったり、松葉杖や T 字杖を用いて少なくとも 3 段は上り下りできる。
 3. 支えも監視もなく少なくとも 3 段は上り下りできる。
- (16) 移乗: 車椅子一車 (車に近づく、車椅子のブレーキ操作、アームレストおよびフットレストの取り外し、車へのからの乗り移り、車椅子の積み降ろし)
0. 全介助を要する。
 1. 部分介助、監視、および補助器具のすべて、もしくはいずれかを必要とする。
 2. 自立して移乗する。補助器具を必要としない(または車椅子を必要としない)。
- (17) 移乗: 床一車椅子
0. 介助を要する。
 1. 補助器具の有無にかかわらず、自立して移乗する(または車椅子を必要としない)。
- 小計 (0-40)

SCIM 合計スコア (0-100)

訳者注

1. 夜間のみ BPAP を使用している場合も 0 点とする
 2. 原書では external drainage instrument、体外からあててるみまがまびく尿器集尿器のことを指す。例えば、コンドーム型集尿器、しびんなどが含まれる。尿道や膀胱に挿入するカテーテルは含まれない
 3. ベッド横やひもなどを使ってもよい
 4. 原書では toilet wheelchair、便器や浴槽に移乗することなく、乗車したまま洋式便器が使用でき、シャワー浴にも使える車椅子のこと。介助型と自立型がある。わが国ではトイレ兼用シャワーキヤリー(介助型)が用いられることがある
- SCIM (Version 3.0) 日本語版 朝川伸之・黒川真希子・出田良輔・星宇明光訳
 [Translated by permission from Dr. Amiram Catz, Loewenstein Rehabilitation Hospital, Raanana, Israel]
 [Reprinted by permission from Macmillan Publishers Ltd. Spinal cord 40: 396-407, copyright 2002]

190x254mm (300 x 300 DPI)

以下のそれぞれの項目の一つの四角に（このように☐）印をつけて、あなた自身の今日の健康状態を最も良く表している記述を示して下さい。

移動の程度

歩き回るのに問題はない

歩き回るのにいくらか問題がある

ベッド（床）に寝たきりである

身の回りの管理

身の回りの管理に問題はない

洗面や着替えを自分でするのにいくらか問題がある

洗面や着替えを自分でできない

ふだんの活動（例：仕事、勉強、家事、家族・余暇活動）

ふだんの活動を行うのに問題はない

ふだんの活動を行うのにいくらか問題がある

ふだんの活動を行うことができない

痛み／不快感

痛みや不快感はない

中程度の痛みや不快感がある

ひどい痛みや不快感がある

不安／ふさぎ込み

不安でもふさぎ込んでもいない

中程度に不安あるいはふさぎ込んでいる

ひどく不安あるいはふさぎ込んでいる

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

健康状態がどのくらい良いか悪いかを表わしてもらうために、(温度計に似たような) 目盛を描きました。目盛には、あなたの想像できる最も良い状態として 100、あなたの想像できる最も悪い状態として 0 が付けられています。

あなたの今日の健康状態がどのくらい良いか悪いかを、あなたの考えでこの目盛上に示して下さい。下の「あなたの今日の健康状態」と書かれた四角から、あなたの現在の健康状態のよし悪しを示す目盛上の点まで、線を引いて下さい。

**あなたの
今日の
健康状態**

想像できる
最も良い
健康状態



想像できる
最も悪い
健康状態

3

Japan (Japanese) © 1997 EuroQol Group EQ-5D™ is a trade mark of the EuroQol Group

190x254mm (300 x 300 DPI)



CONSORT 2010 checklist of information to include when reporting a randomised trial*

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a randomised trial in the title	1
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	3
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale	4-5
	2b	Specific objectives or hypotheses	6
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	6
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	N/A
Participants	4a	Eligibility criteria for participants	7
	4b	Settings and locations where the data were collected	11
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	6-7
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	6-7
	6b	Any changes to trial outcomes after the trial commenced, with reasons	N/A
Sample size	7a	How sample size was determined	8
	7b	When applicable, explanation of any interim analyses and stopping guidelines	N/A
Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	6
	8b	Type of randomisation; details of any restriction (such as blocking and block size)	6
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	8
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	6
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those	8

1			
2		assessing outcomes) and how	
3			
4		11b If relevant, description of the similarity of interventions	N/A
5	Statistical methods	12a Statistical methods used to compare groups for primary and secondary outcomes	8-9
6		12b Methods for additional analyses, such as subgroup analyses and adjusted analyses	N/A
7			
8	Results		
9	Participant flow (a	13a For each group, the numbers of participants who were randomly assigned, received intended treatment, and	N/A
10	diagram is strongly	were analysed for the primary outcome	
11	recommended)	13b For each group, losses and exclusions after randomisation, together with reasons	N/A
12	Recruitment	14a Dates defining the periods of recruitment and follow-up	N/A
13		14b Why the trial ended or was stopped	N/A
14	Baseline data	15 A table showing baseline demographic and clinical characteristics for each group	N/A
15	Numbers analysed	16 For each group, number of participants (denominator) included in each analysis and whether the analysis was	N/A
16		by original assigned groups	
17			
18	Outcomes and	17a For each primary and secondary outcome, results for each group, and the estimated effect size and its	N/A
19	estimation	precision (such as 95% confidence interval)	
20		17b For binary outcomes, presentation of both absolute and relative effect sizes is recommended	N/A
21	Ancillary analyses	18 Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing	N/A
22		pre-specified from exploratory	
23			
24	Harms	19 All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	N/A
25			
26	Discussion		
27	Limitations	20 Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	N/A
28	Generalisability	21 Generalisability (external validity, applicability) of the trial findings	N/A
29	Interpretation	22 Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	N/A
30			
31	Other information		
32	Registration	23 Registration number and name of trial registry	3
33	Protocol	24 Where the full trial protocol can be accessed, if available	3
34	Funding	25 Sources of funding and other support (such as supply of drugs), role of funders	11
35			

36

37 *We strongly recommend reading this statement in conjunction with the CONSORT 2010 Explanation and Elaboration for important clarifications on all the items. If relevant, we also

38 recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological treatments, herbal interventions, and pragmatic trials.

39 Additional extensions are forthcoming: for those and for up to date references relevant to this checklist, see www.consort-statement.org.

40

41

BMJ Open

Study Protocol for the G-SPIRIT trial: A Randomized, Placebo-Controlled, Double-blinded Phase 3 Trial of Granulocyte Colony Stimulating Factor-Mediated Neuroprotection for Acute Spinal Cord Injury

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-019083.R2
Article Type:	Protocol
Date Submitted by the Author:	20-Nov-2017
Complete List of Authors:	<p>Koda, Masao; G-SPIRIT Study Group; University of Tsukuba, Department of Orthopedic Surgery Hanaoka, Hideki; G-SPIRIT Study Group; Chiba University Hospital, Clinical Research Center Sato, Takatoshi; G-SPIRIT Study Group; Chiba University Hospital, Clinical Research Center Fujii, Yasuhisa; G-SPIRIT Study Group; Chiba University Hospital, Clinical Research Center Hanawa, Michiko; G-SPIRIT Study Group; Chiba University Hospital, Clinical Research Center Takahashi, Sho; G-SPIRIT Study Group; Chiba University Hospital, Clinical Research Center Furuya, Takeo; G-SPIRIT Study Group; Graduate School of Medicine, Chiba University, Department of Orthopaedic Surgery Ijima, Yasushi; G-SPIRIT Study Group; Graduate School of Medicine, Chiba University, Department of Orthopaedic Surgery Saito, Junya; G-SPIRIT Study Group; Graduate School of Medicine, Chiba University, Department of Orthopaedic Surgery Kitamura, Mitsuhiro; G-SPIRIT Study Group; Graduate School of Medicine, Chiba University, Department of Orthopaedic Surgery Ohtori, Seiji; G-SPIRIT Study Group; Graduate School of Medicine, Chiba University, Department of Orthopaedic Surgery Matsumoto, Yukei; G-SPIRIT Study Group; University of Tsukuba, Department of Orthopedic Surgery Abe, Tetsuya; G-SPIRIT Study Group; University of Tsukuba, Department of Orthopedic Surgery Watanabe, Kei; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Hirano, Toru; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Ohashi, Masayuki; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Shoji, Hirokazu; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Mizouchi, Tatsuki; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Takahashi, Ikuko; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Kawahara, Norio; G-SPIRIT Study Group; Kanazawa Medical University,</p>

1	
2	
3	
4	Orthopaedic Surgery
5	Kawaguchi, Masahito; G-SPIRIT Study Group; Kanazawa Medical
6	University, Orthopaedic Surgery
7	Orita, Yugo; G-SPIRIT Study Group; Kanazawa Medical University,
8	Orthopaedic Surgery
9	Sasamoto, Takeshi; G-SPIRIT Study Group; Kanazawa Medical University,
10	Orthopaedic Surgery
11	Yoshioka, Masahito; G-SPIRIT Study Group; Kanazawa Medical University,
12	Orthopaedic Surgery
13	Fujii, Masafumi; G-SPIRIT Study Group; Kanazawa Medical University,
14	Orthopaedic Surgery
15	Yonezawa, Katsutaka; G-SPIRIT Study Group; Kanazawa Medical
16	University, Orthopaedic Surgery
17	Soma, Daisuke; G-SPIRIT Study Group; Kanazawa Medical University,
18	Orthopaedic Surgery
19	Taneichi, Hiroshi; G-SPIRIT Study Group; Dokkyo Ika Daigaku, Department
20	of Orthopedic Surgery
21	Takeuchi, Daisaku; G-SPIRIT Study Group; Dokkyo Ika Daigaku,
22	Department of Orthopedic Surgery
23	Inami, Satoshi; G-SPIRIT Study Group; Dokkyo Ika Daigaku, Department
24	of Orthopedic Surgery
25	Moridaira, Hiroshi; G-SPIRIT Study Group; Dokkyo Ika Daigaku,
26	Department of Orthopedic Surgery
27	Ueda, Haruki; G-SPIRIT Study Group; Dokkyo Ika Daigaku, Department of
28	Orthopedic Surgery
29	Asano, Futoshi; G-SPIRIT Study Group; Dokkyo Ika Daigaku, Department
30	of Orthopedic Surgery
31	Shibao, Yosuke; G-SPIRIT Study Group; Dokkyo Ika Daigaku, Department
32	of Orthopedic Surgery
33	Aita, Ikuo; G-SPIRIT Study Group; Tsukuba Medical Center Byoin,
34	Department of Orthopedic Surgery
35	Takeuchi, Yosuke; G-SPIRIT Study Group; Tsukuba Medical Center Byoin,
36	Department of Orthopedic Surgery
37	Mimura, Masaya; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
38	Department of Orthopedic Surgery
39	Shimbo, Jun; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
40	Department of Orthopedic Surgery
41	Someya, Yukio; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
42	Department of Orthopedic Surgery
43	Ikenoue, Sumio; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
44	Department of Orthopedic Surgery
45	Sameda, Hiroaki; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
46	Department of Orthopedic Surgery
47	Takase, Kan; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
48	Department of Orthopedic Surgery
49	Ikeda, Yoshikazu; G-SPIRIT Study Group; Chiba Rosai Byoin, Department
50	of Orthopedic Surgery
51	Nakajima, Fumitake; G-SPIRIT Study Group; Chiba Rosai Byoin,
52	Department of Orthopedic Surgery
53	Hashimoto, Mitsuhiro; G-SPIRIT Study Group; Chiba Rosai Byoin,
54	Department of Orthopedic Surgery
55	Ozawa, Tomoyuki; G-SPIRIT Study Group; Chiba Rosai Byoin, Department
56	of Orthopedic Surgery
57	Hasue, Fumio; G-SPIRIT Study Group; Kimitsu Chuo Byoin, Department of
58	Orthopedic Surgery
59	Fujiyoshi, Takayuki; G-SPIRIT Study Group; Kimitsu Chuo Byoin,
60	Department of Orthopedic Surgery
	Kamiya, Koshiro; G-SPIRIT Study Group; Kimitsu Chuo Byoin, Department
	of Orthopedic Surgery
	Watanabe, Masahiko; G-SPIRIT Study Group; Tokai Daigaku Igakubu
	Seikei Gekagaku, Department of Orthopedic Surgery

1	
2	
3	
4	Katoh, Hiroyuki; G-SPIRIT Study Group; Tokai Daigaku - Isehara Campus,
5	Department of Orthopedic Surgery
6	Matsuyama, Yukihiro; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
7	Department of Orthopedic Surgery
8	Yamato, Yu; G-SPIRIT Study Group; Hamamatsu Ika Daigaku, Department
9	of Orthopedic Surgery
10	Togawa, Daisuke; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
11	Department of Orthopedic Surgery
12	Hasegawa, Tomohiko; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
13	Department of Orthopedic Surgery
14	Kobayashi, Sho; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
15	Department of Orthopedic Surgery
16	Yoshida, Go; G-SPIRIT Study Group; Hamamatsu Ika Daigaku, Department
17	of Orthopedic Surgery
18	Oe, Shin; G-SPIRIT Study Group; Hamamatsu Ika Daigaku, Department of
19	Orthopedic Surgery
20	Banno, Tomohiro; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
21	Department of Orthopedic Surgery
22	Arima, Hideyuki; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
23	Department of Orthopedic Surgery
24	Akeda, Koji; G-SPIRIT Study Group; Mie Daigaku Daigakuin Igakukei
25	Kenkyuka Igakubu, Department of Orthopedic Surgery
26	Kawamoto, Eiji; G-SPIRIT Study Group; Mie Daigaku Daigakuin Igakukei
27	Kenkyuka Igakubu, Department of Orthopedic Surgery
28	Imai, Hiroshi; G-SPIRIT Study Group; Mie Daigaku Daigakuin Igakukei
29	Kenkyuka Igakubu, Department of Orthopedic Surgery
30	Sakakibara, Toshihiko; G-SPIRIT Study Group; Mie Daigaku Daigakuin
31	Igakukei Kenkyuka Igakubu, Department of Orthopedic Surgery
32	Sudo, Akihiro ; G-SPIRIT Study Group; Mie Daigaku Daigakuin Igakukei
33	Kenkyuka Igakubu, Department of Orthopedic Surgery
34	Ito, Yasuo; G-SPIRIT Study Group; Kobe Sekijuji Byoin, Department of
35	Orthopedic Surgery
36	Kikuchi, Tsuyoshi; G-SPIRIT Study Group; Kobe Sekijuji Byoin, Department
37	of Orthopedic Surgery
38	Osaki, Shuhei; G-SPIRIT Study Group; Kobe Sekijuji Byoin, Department of
39	Orthopedic Surgery
40	Tanaka, Nobuhiro; G-SPIRIT Study Group; Hiroshima Daigaku Igakubu
41	Daigakuin Ishiyaku Hokengaku Kenkyuka, Department of Orthopedic
42	Surgery
43	Nakanishi, Kazuyoshi; G-SPIRIT Study Group; Hiroshima Daigaku Igakubu
44	Daigakuin Ishiyaku Hokengaku Kenkyuka, Department of Orthopedic
45	Surgery
46	Kamei, Naosuke; G-SPIRIT Study Group; Hiroshima Daigaku Igakubu
47	Daigakuin Ishiyaku Hokengaku Kenkyuka, Department of Orthopedic
48	Surgery
49	Kotaka, Shinji; G-SPIRIT Study Group; Hiroshima Daigaku Igakubu
50	Daigakuin Ishiyaku Hokengaku Kenkyuka, Department of Orthopedic
51	Surgery
52	Baba, Hideo; G-SPIRIT Study Group; Nagasaki Rosai Byoin, Department of
53	Orthopedic Surgery
54	Okudaira, Tsuyoshi; G-SPIRIT Study Group; Nagasaki Rosai Byoin,
55	Department of Orthopedic Surgery
56	Hiroaki, Konishi; G-SPIRIT Study Group; Nagasaki Rosai Byoin,
57	Department of Orthopedic Surgery
58	Yamaguchi, Takayuki; G-SPIRIT Study Group; Nagasaki Rosai Byoin,
59	Department of Orthopedic Surgery
60	Ito, Keigo; G-SPIRIT Study Group; Chubu Rosai Byoin, Department of
	Orthopedic Surgery
	Katayama, Yoshito; G-SPIRIT Study Group; Chubu Rosai Byoin,
	Department of Orthopedic Surgery
	Matsumoto, Taro; G-SPIRIT Study Group; Chubu Rosai Byoin, Department

	<p>of Orthopedic Surgery Matsumoto, Tomohiro; G-SPIRIT Study Group; Chubu Rosai Byoin, Department of Orthopedic Surgery Idota, Masaru; G-SPIRIT Study Group; Chubu Rosai Byoin, Department of Orthopedic Surgery Kanno, Haruo; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Aizawa, Toshimi; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Hashimoto, Ko; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Eto, Toshimitsu; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Sugaya, Takehiro; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Matsuda, Michiharu; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Fushimi, Kazunari; G-SPIRIT Study Group; Gifu Daigaku Igakubu Daigakuin Igaku Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Nozawa, Satoshi; G-SPIRIT Study Group; Gifu Daigaku Igakubu Daigakuin Igaku Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Iwai, Chizuo; G-SPIRIT Study Group; Gifu Daigaku Igakubu Daigakuin Igaku Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Taguchi, Toshihiko; G-SPIRIT Study Group; Yamaguchi Daigaku Igakubu Daigakuin Igakukei Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Kanchiku, Tsukasa; G-SPIRIT Study Group; Yamaguchi Daigaku Igakubu Daigakuin Igakukei Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Suzuki, Hidenori; G-SPIRIT Study Group; Yamaguchi Daigaku Igakubu Daigakuin Igakukei Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Nishida, Norihiro; G-SPIRIT Study Group; Yamaguchi Daigaku Igakubu Daigakuin Igakukei Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Funaba, Masahiro; G-SPIRIT Study Group; Yamaguchi Daigaku Igakubu Daigakuin Igakukei Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Yamazaki, Masashi; G-SPIRIT Study Group; University of Tsukuba, Department of Orthopedic Surgery</p>
Primary Subject Heading:	Neurology
Secondary Subject Heading:	Medical management
Keywords:	Neurological injury < NEUROLOGY, Spine < ORTHOPAEDIC & TRAUMA SURGERY, Clinical trials < THERAPEUTICS

SCHOLARONE™
 Manuscripts

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Study Protocol for the G-SPIRIT trial: A Randomized, Placebo-Controlled, Double-blinded Phase 3 Trial of Granulocyte Colony Stimulating Factor-Mediated Neuroprotection for Acute Spinal Cord Injury

Corresponding Author: Masao Koda

1-1-1 Tennodai, Tsukuba City, Ibaraki 3058575, Japan

e-mail: masaokod@gmail.com, tel: 81-29-853-3219

Authors: Masao Koda^{1,2}, Hideki Hanaoka^{1,3}, Takatoshi Sato^{1,3}, Yasuhisa Fujii^{1,3}, Michiko Hanawa^{1,3}, Sho Takahashi^{1,3}, Takeo Furuya^{1,4}, Yasushi Ijima^{1,4}, Junya Saito^{1,4}, Mitsuhiro Kitamura^{1,4}, Seiji Ohtori^{1,4}, Yukei Matsumoto^{1,2}, Tetsuya Abe^{1,2}, Kei Watanabe^{1,5}, Toru Hirano^{1,5}, Masayuki Ohashi^{1,5}, Hirokazu Shoji^{1,5}, Tatsuki Mizouchi^{1,5}, Ikuko Takahashi^{1,5}, Norio Kawahara^{1,6}, Masahito Kawaguchi^{1,6}, Yugo Orita^{1,6}, Takeshi Sasamoto^{1,6}, Masahito Yoshioka^{1,6}, Masafumi Fujii^{1,6}, Katsutaka Yonezawa^{1,6}, Daisuke Soma^{1,6}, Hiroshi Taneichi^{1,7}, Daisaku Takeuchi^{1,7}, Satoshi Inami^{1,7}, Hiroshi Moridaira^{1,7}, Haruki Ueda^{1,7}, Futoshi Asano^{1,7}, Yosuke Shibao^{1,7}, Ikuo Aita^{1,8}, Yosuke Takeuchi^{1,8}, Masaya Mimura^{1,9}, Jun Shimbo^{1,9}, Yukio Someya^{1,9}, Sumio Ikenoue^{1,9}, Hiroaki Sameda^{1,9}, Kan Takase^{1,9}, Yoshikazu Ikeda^{1,10}, Fumitake Nakajima^{1,10}, Mitsuhiro Hashimoto^{1,10}, Tomoyuki Ozawa^{1,10}, Fumio Hasue^{1,11}, Takayuki Fujiyoshi^{1,11}, Koshiro Kamiya^{1,11}, Masahiko Watanabe^{1,12}, Hiroyuki Katoh^{1,12}, Yukihiro Matsuyama^{1,13}, Yu Yamamoto^{1,13}, Daisuke Togawa^{1,13}, Tomohiko Hasegawa^{1,13}, Sho Kobayashi^{1,13}, Go Yoshida^{1,13}, Shin Oe^{1,13}, Tomohiro Banno^{1,13}, Hideyuki Arima^{1,13}, Koji Akeda^{1,14}, Eiji Kawamoto^{1,14}, Hiroshi Imai^{1,14}, Toshihiko Sakakibara^{1,14}, Akihiro Sudo^{1,14}, Yasuo Ito^{1,15}, Tsuyoshi Kikuchi^{1,15}, Shuhei Osaki^{1,15}, Nobuhiro Tanaka^{1,16}, Kazuyoshi Nakanishi^{1,16}, Naosuke Kamei^{1,16}, Shinji Kotaka^{1,16}, Hideo Baba^{1,17}, Tsuyoshi Okudaira^{1,17}, Hiroaki Konishi^{1,17}, Takayuki Yamaguchi^{1,17}, Keigo Ito^{1,18}, Yoshito Katayama^{1,18}, Taro Matsumoto^{1,18}, Tomohiro Matsumoto^{1,18}, Masaru Idota^{1,18}, Haruo Kanno^{1,19}, Toshimi Aizawa^{1,19}, Ko Hashimoto^{1,19}, Toshimitsu Eto^{1,19}, Takehiro Sugaya^{1,19}, Michiharu Matsuda^{1,19}, Kazunari Fushimi^{1,20}, Satoshi Nozawa^{1,20}, Chizuo Iwai^{1,20}, Toshihiko Taguchi^{1,21}, Tsukasa Kanchiku^{1,21}, Hidenori Suzuki^{1,21}, Norihiro Nishida^{1,21}, Masahiro Funaba^{1,21}, Masashi Yamazaki^{1,2}

1
2
3
4
5 Affiliations
6

7 ¹G-SPIRIT Study Group is consisted by Nineteen major hospitals in Japan constituting the
8 G-SPIRIT study group
9

10 ²Department of Orthopedic Surgery, University of Tsukuba, Ibaraki

11 ³Clinical Research Center, Chiba University Hospital, Chiba

12 ⁴Department of Orthopedic Surgery, Chiba University Graduate School of Medicine, Chiba

13 ⁵Department of Orthopedic Surgery, Niigata University Graduate School of Medicine and
14 Dental Sciences, Niigata
15

16 ⁶Department of Orthopedic Surgery, Kanazawa Medical University, Ishikawa

17 ⁷Department of Orthopedic Surgery, Dokkyo Medical University, Tochigi

18 ⁸Department of Orthopedic Surgery, Tsukuba Medical Center, Ibaraki

19 ⁹Department of Orthopedic Surgery, Funabashi Municipal Medical Center, Chiba

20 ¹⁰Department of Orthopedic Surgery, Chiba Rosai Hospital, Chiba

21 ¹¹Department of Orthopedic Surgery, Kimitsu Chuo Hospital, Chiba

22 ¹²Department of Orthopedic Surgery, Tokai University School of Medicine, Kanagawa

23 ¹³Department of Orthopedic Surgery, Hamamatsu University School of Medicine, Shizuoka

24 ¹⁴Department of Orthopedic Surgery, Graduate School of Medicine, Mie University, Mie

25 ¹⁵Department of Orthopedic Surgery, Kobe Red Cross Hospital, Hyogo

26 ¹⁶Department of Orthopedic Surgery, Graduate School of Biomedical Sciences, Hiroshima
27 University, Hiroshima
28

29 ¹⁷Department of Orthopedic Surgery, Nagasaki Rosai Hospital, Nagasaki

30 ¹⁸Department of Orthopedic Surgery, Chubu Rosai Hospital, Aichi

31 ¹⁹Department of Orthopedic Surgery, Tohoku University School of Medicine, Miyagi

32 ²⁰Department of Orthopedic Surgery, Gifu University School of Medicine, Gifu

33 ²¹Department of Orthopedic Surgery, Yamaguchi University Graduate School of Medicine,
34 Yamaguchi
35

36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52 Word Count: 2516
53
54
55
56
57

Abstract

Introduction: Granulocyte Colony Stimulating Factor (G-CSF) is generally used for neutropenia. Previous experimental studies revealed that G-CSF promoted neurological recovery after spinal cord injury (SCI). Next we moved to early phase of clinical trials. In a phase 1/2a trial, no adverse events were observed. Next, we conducted a non-randomized, non-blinded, comparative trial, which suggested the efficacy of G-CSF for promoting neurological recovery. Based on those results, we are now performing a phase 3 trial.

Methods and Analysis: The objective of this study is to evaluate the efficacy of G-CSF for acute SCI. The study design is a prospective, multicenter, randomized, double-blinded, placebo-controlled comparative study. The current trial includes cervical SCI (severity of American Spinal Injury Association (ASIA) Impairment Scale B/C) within 48 hours after injury. Patients are randomly assigned to G-CSF and placebo groups. The G-CSF group is administered 400 $\mu\text{g}/\text{m}^2/\text{d}\times 5\text{d}$ of G-CSF in normal saline via intravenous infusion for 5 consecutive days. The placebo group is similarly administered a placebo. Our primary endpoint is changes in ASIA motor scores from baseline to 3 months. Each group includes 44 patients (88 total patients). This trial is funded by the Center for Clinical Trials, Japan Medical Association.

Ethics and Dissemination: The study was approved by the Institutional Review Board of each institution and will be conducted according to the principles of the World Medical Association Declaration of Helsinki and in accordance with the Japanese Medical Research Involving Human Subjects Act and other guidelines, regulations and Acts. Results of the clinical study will be submitted to the head of the respective clinical study site as a report after conclusion of the clinical study by the sponsor-investigator. Even if the results are not favorable despite conducting the clinical study properly, the data will be published as a paper.

Registration: UMIN000018752

<https://upload.umin.ac.jp/cgi-open-bin/ctr/ctr.cgi?function=brows&action=brows&type=summary&recptno=R000021694&language=J>

Strengths and Limitations of This Study

Strengths

- ✓ Novel drug therapy for acute spinal cord injury is much-needed.
- ✓ Randomized, placebo-controlled, double-blinded design can eliminate bias.

Limitations

- ✓ Acute spinal cord injury patients are difficult to recruit to the trial.
- ✓ Patient's neurological status in acute phase is unstable, possibly resulting in dispersion of the patient's background.
- ✓ Concealment must be performed very strictly because G-CSF apparently increases

white blood cell count.

Introduction

Spinal cord injury (SCI) is a devastating injury by which the patient can suffer from long-lasting severe sequelae including palsy of extremities, sensory disturbance, bowel/bladder/sexual dysfunction, and neuropathic pain. Conceptually, SCI is divided into two chronological phases: a primary and a secondary phase. Primary injury is mechanical damage to spinal cord tissue itself caused by fracture and/or dislocation or compression. Secondary injury is triggered by the primary injury and is a biological reaction of the spinal cord, which includes ischemia, hemorrhage, excitotoxicity, hyperpermeability, and inflammation¹. Because secondary injury can be the main target of treatment, extensive laboratory and clinical investigation of neuroprotection is needed to manage secondary injury².

To date, the only approved neuroprotective therapy for SCI is massive methylprednisolone sodium succinate (MPSS) therapy based on the NASCIS 2 study³. However, recent reports revealed that MPSS shows only a modest effect for SCI. In addition, several reports have described adverse events induced by MPSS for SCI including infections (pneumonia, urinary tract infection) and gastrointestinal disorders (gastric ulcer, etc.)⁴. Therefore, the use of MPSS for SCI has become controversial⁵. Accordingly, a new therapeutic drug for SCI is desirable.

Granulocyte colony-stimulating factor (G-CSF, generic name: filgrastim) is a growth factor that affects the hematopoietic system, promoting differentiation, proliferation, and survival of granulocytes⁶. Clinically, in Japan, G-CSF is administered to patients with leukopenia, and to peripheral stem cell transplantation donors, G-CSF is administered to mobilize hematopoietic stem cells into the peripheral blood⁷. In the central nervous system, G-CSF has properties to mobilize the movement of bone marrow cells into the brain⁸ and spine, and in a stroke model, has shown neuroprotective properties⁹. In other countries, clinical studies of the effects of G-CSF in cerebral infarction have been reported¹⁰.

To prove the hypothesis that G-CSF has neuroprotective properties against SCI, G-CSF was administered to rat and mouse animal models of spinal cord injury, and hind limb

1
2
3
4
5
6 function improved significantly after administration of G-CSF. Further investigations into
7 the mechanism of action of G-CSF in SCI were conducted. Data obtained to date identify
8 the following properties of G-CSF: [1] mobilization of bone marrow-derived stem cells
9 causing their biointegration at the site of SCI¹¹, [2] direct inhibition of nerve cell death¹²,
10 [3] protection of the myelin sheath by inhibiting oligodendrocyte cell death¹³, [4] inhibition
11 of inflammatory cytokine expression (TNF- α , IL-1 β)¹³, and [5] promotion of
12 neovascularization¹⁴. These properties suggest that G-CSF has a neuroprotective effect in
13 acute SCI.
14
15

16
17
18
19 Based on these properties, a phase 1/2a clinical study was conducted where the main
20 objective was to confirm the safety and feasibility of G-CSF for treatment of patients with
21 acute SCI¹⁵. This study was an open-label, dose-titrating study with no control group. As
22 the initial step, 5 patients were given 5 $\mu\text{g}/\text{kg}/\text{day}$ of G-CSF for 5 consecutive days by i.v.
23 infusion, and as the second step, 11 patients were given 10 $\mu\text{g}/\text{kg}/\text{day}$ of G-CSF for 5
24 consecutive days by i.v. infusion. No serious adverse events were noted, and the safety of
25 G-CSF administration in patients with acute SCI was confirmed¹⁵.
26
27
28
29
30

31 As a next step, to validate the efficacy of G-CSF in neuroprotective treatment, a
32 multicenter, prospective, nonrandomized, nonblinded, comparative control study (phase 2b
33 clinical trial) was conducted¹⁶. Based on the results of the previous phase 1/2a clinical trial,
34 the dosage and duration of treatment with G-CSF in this study was 10 $\mu\text{g}/\text{kg}/\text{day}$ for 5
35 consecutive days. Patients with acute cervical SCI (within 48 h of injury) were registered in
36 the clinical trial and allocated to either the G-CSF group (G-CSF 10 $\mu\text{g}/\text{kg}/\text{day} \times 5$ days i.v.
37 infusion) or control group (no G-CSF administration) at each treatment facility. A total of
38 19 patients in the G-CSF group and 26 patients in the control group were observed for 3
39 months or longer. American Spinal Injury Association (ASIA) motor score (motor: 0 to 100
40 points) was compared between the groups. ASIA motor scores were 26.1 ± 18.9 in the
41 G-CSF group and 12.2 ± 14.7 in the control group showing a significant improvement of
42 motor paralysis in the G-CSF group ($p < 0.01$). In addition, in cases that could be followed
43 for 1 year or longer, a significant improvement of ASIA motor score was observed in the
44 G-CSF group¹⁶.
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5 Based on results of these preclinical and early phase clinical trials, we are now
6 conducting a phase 3 trial.
7
8
9

10 *Specific Objective*

11 The objective of this study is to evaluate the efficacy of G-CSF for improving motor
12 paralysis in acute SCI.
13
14
15

16 **Methods and Analysis**

17 *Design of the study*

18 The study design of the current trial is a prospective, multicenter, randomized,
19 double-blinded, placebo-controlled comparative study.
20
21
22
23
24
25

26 *Study Procedures*

27 The study outline is shown in Figure. Patients will be randomly assigned to G-CSF and
28 placebo groups. A central registration system will be used for dynamic randomization into
29 the investigational treatment group (G-CSF) and control group (placebo) based on age at
30 registration (16–64 years of age, or 65–84 years of age) and severity of paralysis (AIS B or
31 C) at 48 h after injury. With or without the surgical stabilization and/or decompression was
32 not included in stratification. Initially, screened patients with severity AIS B/C will be
33 tentatively enrolled. Initial screening of the patients include clinical laboratory test, imaging
34 studies including X-ray, magnetic resonance imaging and computed tomography, and
35 neurological/functional evaluations.
36
37
38
39
40
41
42

43 Neurological re-assessment will be performed 48±4 hours after SCI and the patients
44 who will recover to severity AIS D will be excluded. The patients with severity AIS B/C at
45 neurological re-assessment 48±4 hours after SCI will be enrolled and randomly allocated to
46 either the investigational treatment group (G-CSF) or control group (placebo) in a 1 to 1
47 ratio. The subject registration center uses a program based on an appropriate computer
48 algorithm to allocate patients into groups. The first dose of investigative drugs will be
49 administered to the patients after re-assessment of neurological status and enrollment 48±4
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5 hours after SCI.
6

7 The G-CSF group will be administered $400 \mu\text{g}/\text{m}^2/\text{d} \times 5\text{d}$ of G-CSF in normal saline via
8 intravenous infusion for 5 consecutive days. The placebo group will be similarly
9 administered a placebo. The first dose of investigative drugs will be administered to the
10 patients 48 ± 4 hours after SCI. The dosing schedule will be once a day in every morning
11 (9-10 AM) for consecutive 5 days even in case that the first dosing was performed at night
12 because of restriction on practices. Investigational drugs including both G-CSF and placebo
13 will be stored in refrigerator which will be kept between $1-6^\circ\text{C}$ and has temperature-logger
14 in pharmacies in each participating institutes. The investigational drugs is packaged in
15 ample with label only printed as serial numbers, ten ample is packed in one box with label
16 only printed serial numbers. Web-based allocation system will show the serial number of
17 investigational drug which must be used to respective patients to ensure blinding.
18
19
20
21
22
23
24
25

26 We decided dosage of drug based on our previous non-randomized early phase clinical
27 studies. On phase 1/2a clinical study, of which study design was open-label, dose-titrating
28 study with no control group, SCI patients who were administered $10 \mu\text{g}/\text{kg}/\text{day}$ G-CSF
29 for 5 days showed marked elevation of white blood cell number (reached nearly $50000/\mu\text{L}$,
30 of which WBC number might cause adverse effects of G-CSF) during G-CSF
31 administration¹⁵. Therefore we decided to withdraw additional titration. In addition, next
32 phase of clinical study, of which design was multicenter, prospective, nonrandomized,
33 nonblinded, comparative control study, showed suggestive efficacy of G-CSF ($10 \mu\text{g}/\text{kg}/\text{d}$
34 for 5 days) for acute SCI¹⁶. Based on those results, we finally decided the dosage of G-CSF
35 as $10 \mu\text{g}/\text{kg}/\text{d} \times 5\text{d}$ for 5 days. In the current clinical trial, the dosage of G-CSF is written as
36 $400 \mu\text{g}/\text{m}^2/\text{d}$ ($= 10 \mu\text{g}/\text{kg}/\text{d}$) according to the Japanese Pharmaceutical and Medical Device
37 Agency (PMDA)'s instruction for consolidation with product labeling.
38
39
40
41
42
43
44
45
46

47 We decided to 48hours after SCI as the therapeutic time window because our previous
48 multicenter, prospective, nonrandomized, nonblinded, comparative control study, which
49 recruited SCI patients within 48 hours after injury, showed that there was no significant
50 difference in neurological outcome between the patient administered G-CSF very early
51 after the injury and 48 hours after injury¹⁶.
52
53
54
55
56
57
58
59
60

1
2
3
4
5 Allocation will be concealed between blinded evaluators of efficacy/safety and those
6 for laboratory data, as G-CSF markedly increases white blood cell counts that can reveal
7 patient treatment.
8
9

10 Our primary endpoint is changes in ASIA motor scores (international standards for
11 neurological classification of spinal cord injury (ISNSCI) suppl. Figure 1) from baseline to
12 3 months calculated as follows: 3-month ASIA motor score change = 3-month ASIA motor
13 score – pretreatment ASIA motor score. To maintain consistency of neurological
14 assessment among the each evaluators, attending lecture and e-learning (in website of
15 International Spinal Cord Society: <http://www.elearnsoci.org/>) of ASIA/ISNSCI scoring
16 system is mandatory for every investigators participating to the present trial.
17
18
19
20
21
22

23 Secondary endpoints are as follows. [1] Change in ASIA motor scores at 6 months and
24 12 months after G-CSF administration compared with pretreatment. [2] Changes in sensory
25 paralysis over time: change in ASIA sensory scores at 3 months, 6 months, and 12 months
26 after G-CSF administration compared with pretreatment. [3] Severity of functional
27 compromise because of paralysis: AIS before administration and at 3, 6, and 12 months
28 after administration of G-CSF. [4] Percentage of responders: percentage of patients whose
29 AIS improved by 1 grade or more at 3, 6, and 12 months after administration compared
30 with before administration of G-CSF. [5] Neurological level of injury (NLI): percentage of
31 patients whose NLI decreased by 1 grade of more at 3, 6, or 12 months after administration
32 of G-CSF compared with pretreatment. [6] SCIM: change in SCIM scores at 3, 6, and 12
33 months after G-CSF administration compared with pretreatment [7] EQ-5D: measured
34 EQ-5D efficacy scores at 3, 6, and 12 months after G-CSF.
35
36
37
38
39
40
41
42

43 To strengthen the analysis, more strict blindness of assessment by the evaluator for
44 outcome measures is ideal. Therefore every prior score/measurement should be blinded
45 and/or not the same person should assess every midpoint motor/sensory functional
46 measurement. However, PMDA instructed us to assess one patients' functional evaluation
47 by one evaluator for consistent assessment in respective patients. PMDA considers the
48 consistency of assessment in respective patients is more important.
49
50
51
52
53

54 The precise explanation of abovementioned outcome measures is as followings (suppl.
55
56
57

Figures). ASIA motor score is determined by examining a key muscle function within each of 10 myotomes on each side of the body on manual muscle testing (MMT) in the supine position. There is a range of score from 0 to 25 for each extremity, totaling 0 to 50 for the upper limbs and 0 to 50 for the lower limbs, resulting in total of ASIA motor score ranges from 0 to 100. This score can reflect the degree of motor impairment associated with the SCI (suppl. Figure 1). ASIA sensory scores is completed through the testing of a key point in each of the 28 dermatomes (from C2 to S4-5) on the right and left sides of the body that can be readily located in relation to bony anatomical landmarks. At each of these key points, two aspects of sensation are examined: light touch and pin prick. Appreciation of light touch and pin prick sensation at each of the key points is separately scored on a three-point scale, with comparison to the sensation on the patients' cheek as a normal frame of reference: 0 = absent, 1 = altered, 2 = normal or intact. As a result, ASIA sensory scores range from 0 to 112 (suppl. Figure 1). AIS designation is used in grading the degree of impairment: A = Complete. No sensory or motor function is preserved in the sacral segments S4-S5. B = Sensory incomplete. Sensory but not motor function is preserved below the neurological level. C = Motor incomplete. Motor function is preserved below the neurological level, and more than half of key muscle functions below the single neurological level of injury have a muscle grade less than 3 (Grades 0–2). D = Motor incomplete. Motor function is preserved below the neurological level, and at least half (half or more) of key muscle functions below the neurological level have a muscle grade >3. E = Normal. If sensation and motor function as tested are graded as normal in all segments, and the patient had prior deficits, then the AIS grade is E (suppl. Figure 1, footnote). NLI refers to the most caudal segment of the cord with intact sensation and antigravity muscle function strength, provided that there is normal (intact) sensory and motor function rostrally (suppl. Figure 1, footnote). SCIM is disability scale developed specifically for patients with spinal cord lesions in order to make the functional assessments of patients with paraplegia or tetraplegia more sensitive to changes. The SCIM includes the following areas of function: self-care (subscore (0-20), respiration and sphincter management (0-40) and mobility (0-40). Each area is scored according to its proportional weight in these patients'

1
2
3
4
5
6 general activity. The final score ranges from 0 to 100 (suppl. Figure 2-4). EQ-5D
7 essentially consists of 2 pages (suppl. Figure 5, 6): the EQ-5D descriptive system and the
8 EQ visual analogue scale (EQ VAS). The descriptive system comprises five dimensions:
9 mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Each
10 dimension has 5 levels: no problems, slight problems, moderate problems, severe problems
11 and extreme problems. The patient is asked to indicate his/her health state by ticking the
12 box next to the most appropriate statement in each of the five dimensions. This decision
13 results in a 1-digit number that expresses the level selected for that dimension. The digits
14 for the five dimensions can be combined into a 5-digit number that describes the patient's
15 health state and can be converted to efficacy score with calibration scale (ranges -0.111 to
16 1.000). The EQ VAS records the patient's self-rated health on a vertical visual analogue
17 scale, where the endpoints are labelled 'The best health you can imagine' and 'The worst
18 health you can imagine'. The VAS can be used as a quantitative measure of health outcome
19 that reflect the patient's own judgement.
20
21
22
23
24
25
26
27
28
29

30
31 Each group will include 44 patients (88 patients in total). Our protocol was approved by
32 PMDA and this trial will be funded by the Center for Clinical Trials, Japan Medical
33 Association.
34
35
36
37
38

39 *Inclusion*

40 Inclusion criteria are as follows. [1] Patients with cervical SCI (severity of AIS B/C)
41 within 48 h of injury. [2] Patients reassessed for neurological status at 48 h after injury, and
42 those whose palsy is AIS B/C will be enrolled. [3] Patients with neurological level of injury
43 between C4 and C7. [4] Patients with age of 16 to 85 years. [5] Patients who agree to
44 participate in the current trial and from whom informed consent was obtained orally and in
45 writing. [6] Patients who can be followed up for 12 months after SCI.
46
47
48
49
50
51

52 *Exclusion*

53 Exclusion criteria are as follows. [1] Patients with neurological recovery to AIS D at
54
55
56
57

1
2
3
4
5
6 neurological reassessment 48 h after SCI, because only AIS B/C patients will be included to
7 standardize the severity of paresis in order to stratify the patients at the initiation of drug
8 administration. [2] Allergy to G-CSF. [3] Hematological malignancy, [4] within 6 months
9 after invasive coronary intervention, [5] splenomegaly, or [6] pregnancy, [7] consciousness
10 impairment, [8] neurological disorders that can affect neurological evaluation in the present
11 trial, [9] fracture of extremities that can affect the neurological evaluation and [10] massive
12 dose administration of MPSS. Exclusion criteria 2 - 6 are set for safety, criteria 1, 7 - 9 are
13 set to maintain homogeneity of the patient population enrolled, criteria 7-9 are set for
14 maintenance of accuracy of functional assessment, criteria 7 is set to obtain patients' own
15 informed consent upon participation to the trial and criteria 10 is set to omit the possible
16 interference of MPSS on outcome assessment.
17
18
19
20
21
22
23
24
25

26 *Concealment*

27
28 Patients will be administered drug or placebo and be evaluated in a double-blinded
29 manner. An evaluator blinded to the treatment will take charge of patient evaluation
30 including clinical findings and paresis, without laboratory data because G-CSF induces an
31 apparent increase of white blood cell count that makes it easy to distinguish G-CSF and
32 placebo treatment. Therefore, a non-blinded evaluator for laboratory data will be assigned
33 to evaluate laboratory data alone. From a safety point-of view, the dose of G-CSF will be
34 modulated according to excessive increase of white blood cell count. Therefore, a
35 non-blinded evaluator will instruct the pharmacy to modulate the dose of G-CSF based on
36 white blood cell count.
37
38
39
40
41
42
43
44

45 *Sample Size Calculation*

46
47 The target sample size for this randomized trial is 88. This number is based on the
48 results of previous clinical trials¹⁶. The estimated group difference (\pm standard deviation) of
49 change in ASIA motor scores from baseline to 3 months is 13.9 (\pm 21.9). A sample size of
50 44 patients in each group will provide 80% power to detect a difference of the change in
51 ASIA motor scores between the G-CSF and the placebo treatments, using a mixed-effects
52
53
54
55
56
57

1
2
3
4
5 models for repeated measures (MMRM) at a two-sided 5% level of significance. A
6 common correlation of 0.25 at each time point is assumed. A dropout rate of 10% is
7 allowed. Thus, the total sample size of 88 patients is required for the trial.
8
9

10 11 12 *Statistical analyses*

13
14 The analyses of the primary and secondary end points will be performed as
15 intention-to-treat analyses in a full analysis set, which includes all patients who: (1) took at
16 least one course of treatment during the study; (2) do not present any serious violation of
17 the study protocol; and (3) have data collected after commencement of treatment. For the
18 baseline characteristics, summary statistics will comprise frequencies and proportions for
19 categorical variables, and means and SDs for continuous variables. The patient
20 characteristics will be compared using a chi-square test for categorical variables, and a *t* test
21 or Wilcoxon rank sum test for continuous variables. Missing data including loss to
22 follow-up and missing measurement will be supplemented with MMRM.
23
24

25 For the primary analysis, aimed at comparing treatment effects, a change in ASIA motor
26 score from baseline to 3 months and its 95% confidence interval (CI) will be estimated
27 using the MMRM. To test for significant association of the primary endpoint, a mixed
28 effects model for repeated measures with an unstructured covariance matrix will be applied
29 to adjust for age (<65 years or ≥65 years) and AIS at 48 h after the injury (B or C).
30
31

32 For the secondary analysis, the change in ASIA motor score will be compared using a
33 Student *t* test and the 95% CI will be estimated. The same method will be applied to change
34 in sensory score, SCIM, and EQ-5D. A chi-squared test will be applied to the frequencies of
35 the responder in AIS and of the improvement in NLI. The frequency of AIS will be
36 summarized. The frequency of AEs will be compared using a Fisher exact test.
37
38

39 All comparisons are planned and all *p* values will be two sided. $p < 0.05$ will be
40 considered significant. All statistical analyses will be performed using SAS software
41 (version 9.4; SAS Institute, Cary, NC, USA). The statistical analysis plan will be developed
42 by the principal investigator and the biostatistician before completion of patient recruitment
43 and fixing of data.
44
45
46
47
48
49
50
51
52
53
54
55
56
57

Data Monitoring Committee

The data monitoring committee consists of three clinical trial specialists, including a biostatistician, who are independent from the current study. The committee will meet at least 2 times per year and all the data obtained by the current trial will be checked by the committee.

Adverse Events

As for safety evaluation, adverse events will be collected as follows. “Adverse events” refers to any untoward symptom or disease or signs of such (including clinical laboratory data abnormalities) in a clinical investigation subject after informed consent and does not necessarily have a causal relationship with the investigational product (G-CSF).

Increases in white blood counts will be considered an adverse event only when the count exceeds 50,000/ μ L from the perspective of a pharmacological effect of G-CSF, and any values below this will not be handled as an adverse event. Anaphylaxis and adult respiratory distress syndrome are the most representative G-CSF-related severe adverse events to be paid full attention.

All adverse events will code terminology used by the investigators according to the ICH International Medical Dictionary for Regulatory Activities Japanese version (MedDRA/J).

Ethics and Dissemination

Ethics

The study was approved by the Institutional Review Board (IRB) of each institutions involved to the present trial and will be conducted according to the principles of the World Medical Association (WMA) Declaration of Helsinki—Ethical Principles for Medical Research Involving Human Subjects with the amendments made in Seoul, South Korea, October 2008, with a Note of Clarification on Paragraph 29 added by the WMA General Assembly, Washington 2002; Note of Clarification on Paragraph 30 added by the WMA General Assembly, Tokyo 2004, and in accordance with the Japanese Medical Research

1
2
3
4
5 Involving Human Subjects Act (WMO) and other guidelines, regulations and Acts.
6
7

8
9 *Patient informed consent*

10 The principal investigator will try to prepare the informed consent form and other
11 explanatory materials in as simple language as possible in order to obtain informed consent
12 from the patient and the patient's legal representative. In case that trial participants cannot
13 sign the informed consent form due to upper extremity palsy caused by SCI, allograph by
14 patients' representative will be allowed.
15
16
17
18

19
20
21 *Public Disclosure and Publication Policy*

22 Results of the clinical study will be submitted to the head of the respective clinical
23 study site as a report after conclusion of the clinical study by the sponsor-investigator
24 (includes study coordinating investigator). Even if the results are not favorable despite
25 conducting the clinical study properly, the data will be published as a paper. Other
26 sponsor-investigators (including the clinical study coordinating investigator), if they plan to
27 publicize the data from this study in a specialized academic society conference or other
28 external site, must first obtain permission from the other principal investigators and
29 investigational product provider. In publicizing the results, the confidentiality of the
30 subjects will be maintained and proofread in advance by the other sponsor-investigators
31 (includes coordinating investigator) and investigational product provider.
32
33
34
35
36
37
38
39
40
41

42 **Discussion**

43 The current trial is a confirmative trial to elucidate the therapeutic efficacy of G-CSF
44 for SCI. If the current trial can successfully show significant improvement of motor
45 paralysis of SCI by G-CSF, we will move forward to drug approval application to the
46 Ministry for Health and Labor, Japan. The entire protocol of the current trial was approved
47 beforehand for the initiation of the current trial by the Japanese Pharmaceutical and
48 Medical Device Agency (PMDA). The PMDA will also permit a drug approval application
49 if significant efficacy of G-CSF for SCI is proven.
50
51
52
53
54
55
56
57

1
2
3
4
5 The current trial is an important milestone for SCI clinics and research to explore
6 G-CSF for SCI.
7
8
9

10 *Trial Status*

11 The present trial is now on-going.
12
13

14 *Trial Sites*

15 Nineteen major hospitals in Japan constituting the G-SPIRIT study group as follows:
16 Tohoku University Hospital, Miyagi; Niigata University, Niigata; Dokkyo University
17 Hospital, Tochigi; Tsukuba University Hospital, Ibaraki; Tsukuba Medical Center, Ibaraki;
18 Chiba University Hospital, Chiba; Funabashi Municipal Medical Center, Chiba; Kimitsu
19 Chuo Hospital, Chiba; Chiba Rosai Hospital, Chiba; Tokai University Hospital, Kanagawa;
20 Hamamatsu University Hospital, Shizuoka; Gifu University Hospital, Gifu; Chubu Rosai
21 Hospital, Aichi; Mie University Hospital, Mie; Kanazawa Medical Collage, Ishikawa;
22 Kobe Red Cross Hospital, Hyogo; Hiroshima University Hospital, Hiroshima; Yamaguchi
23 University Hospital, Yamaguchi; and Nagasaki Rosai Hospital, Nagasaki.
24
25
26
27
28
29
30
31
32

33 **Funding Statement**

34 This trial is supported by Center for Clinical trials, Japan Medical Association, Japan.
35
36

37 **Competing Interests**

38 No authors have any competing interests to declare.
39
40
41

42 **Contributorship Statement**

43 MK, TF and MY contributed to planning and conduct of the present trial and to reporting
44 the present protocol paper. HH, TS, YF, MH and ST contributed to conception and design
45 of the present trial protocol and to reporting the present protocol paper. YI, JS, MK, SO,
46 YM, TA, KW, TH, MO, HS, TM, IT, NK, MK. YO, TS, MY, MF, KY, DS, HT, DT, SI,
47 HM, HU, FA, YS, IA, YT, MM, JS, YS, SI, HS, KT, YI, FN, MH, TO, FH, TF, KK, MW,
48 HK, YM, YY, DT, TH, SK, GY, SO, TB, HA, KA, EK, HI, TS, AS, YI, TK, SO, NT, KN,
49 NK, SK, HB, TO, HK, TY, IK, KY, TM, TM, IM, HK, TA, KH, TE, TS, MM, KF, SN, CI,
50
51
52
53
54
55
56
57

1
2
3
4
5 TT, TK, HS, NN and MF contributed to conducting the present trial and to acquisition of
6 data.
7
8
9

10 References

- 11 1. Oyinbo CA. Secondary injury mechanisms in traumatic spinal cord injury: a nugget
12 of multiply cascade. *Acta Neurobiol Exp* 2011;71:281-299.
- 13 2. Karsy M, Hawryluk G. Pharmacologic Management of Acute Spinal Cord Injury.
14 *Neurosurg Clin N Am* 2017;28:49-62. doi: 10.1016/j.nec.2016.07.002.
- 15 3. Bracken MB, Shepard MJ, Collins WF, et al. A randomized controlled trial of
16 methylprednisolone or naloxone in the treatment of acute spinal cord injury: results
17 of the second national acute spinal cord injury study. *N Engl J Med* 1990;322:
18 1405-1411.
- 19 4. Matsumoto T, Tamaki T, Kawakami M, et al. Early complications of high-dose
20 methyl-prednisolone sodium succinate treatment in the follow-up of acute cervical
21 spinal cord injury. *Spine* 2001;26: 426-430.
- 22 5. Hurlbert RJ, Hadley, Walters BC, et al. Pharmacological Therapy for Acute Spinal
23 cord Injury. *Neurosurgery* 2013;72: 93-105.
- 24 6. Nicola NA, Metcalf D, Matsumoto M, Johnson GR. Purification of a factor inducing
25 differentiation in murine myelomonocytic leukemia cells. Identification as
26 granulocyte colony-stimulating factor. *J Biol Chem* 1983;258: 9017-9023.
- 27 7. Roberts AW: G-CSF: a key regulator of neutrophil production, but that's no all!
28 *Growth Factors* 2005;23: 33-41.
- 29 8. Kawada H, Takizawa S, Takanashi T, et al. Administration of hematopoietic
30 cytokines in the subacute phase after cerebral infarction is effective for functional
31 recovery facilitating proliferation of intrinsic neural stem/progenitor cells and
32 transition of bone marrow-derived neuronal cells. *Circulation* 2006;113: 701-710.
- 33 9. Schneider A, Kruger C, Steigleder T, et al. The hematopoietic factor G-CSF is a
34 neuronal ligand that counteracts programmed cell death and drives neurogenesis. *J*
35 *Clin Invest* 2005;115: 2083-2098.
- 36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57

10. Shyu WC, Lin SZ, Lee CC, Liu DD, Li H. Granulocyte colony-stimulating factor for acute ischemic stroke: a randomized controlled trial. *CMAJ* 2006;174: 927-933.
11. Koda M, Nishio Y, Kamada T, et al. Granulocyte colony-stimulating factor (G-CSF) mobilizes bone marrow-derived cells into injured spinal cord and promotes functional recovery after compression-induced spinal cord injury in mice. *Brain Res* 2007;1149: 223-231.
12. Nishio Y, Koda M, Kamada T, et al. Granulocyte colony-stimulating factor (G-CSF) attenuates neuronal death and promotes functional recovery after spinal cord injury in mice. *J Neuropathol Exp Neurol* 2007;66: 724-731.
13. Kadota R, Koda M, Kawabe J, et al. Granulocyte colony-stimulating factor (G-CSF) protects oligodendrocyte and promotes hindlimb functional recovery after spinal cord injury in rats. *PLoS One* 2012;7:e50391.
14. Kawabe J, Koda M, Hashimoto M, et al. Granulocyte colony-stimulating factor (G-CSF) exerts neuroprotective effects via promoting angiogenesis after spinal cord injury in rats. *J Neurosurg Spine* 2011;15: 414-421.
15. Takahashi H, Yamazaki M, Okawa A, et al. Neuroprotective therapy using granulocyte colony-stimulating factor for acute spinal cord injury: a phase I/IIa clinical trial. *Eur Spine J* 2012;21:2580-2587.
16. Inada T, Takahashi H, Yamazaki M, et al. A multicenter prospective non-randomized controlled clinical trial to prove neurotherapeutic effects of granulocyte colony-stimulating factor (G-CSF) for acute spinal cord injury: Analyses of follow-up cases after at least one year. *Spine* 2014;39:213-219.

Figure legend

Schematic diagram showing trial timeline.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY (ISNCSCI)

ASIA AMERICAN SPINAL INJURY ASSOCIATION **ISICOS** INTERNATIONAL STANDARDS FOR CLASSIFICATION OF SPINAL CORD INJURY

Patient Name _____ Date/Time of Exam _____
 Examiner Name _____ Signature _____

RIGHT

MOTOR KEY MUSCLES

Elbow flexors C5
 Wrist extensors C6
 Elbow extensors C7
 Finger flexors C8
 Finger abductors (little finger) T1

UER
(Upper Extremity Right)

LER
(Lower Extremity Right)

Hip flexors L2
 Knee extensors L3
 Ankle dorsiflexors L4
 Long toe extensors L5
 Ankle plantar flexors S1

(VAC) Voluntary anal contraction (Yes/No)

RIGHT TOTALS
(MAXIMUM) (50) (56) (56)

SENSORY KEY SENSORY POINTS
Light Touch (LTR) Pin Prick (PPR)

C2
C3
C4
C5
C6
C7
C8
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
L1
L2
L3
L4
L5
S1
S2
S3
S4-5

SENSORY KEY SENSORY POINTS
Light Touch (LTL) Pin Prick (PPL)

C2
C3
C4
C5
C6
C7
C8
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
L1
L2
L3
L4
L5
S1
S2
S3
S4-5

LEFT

Elbow flexors C5
 Wrist extensors C6
 Elbow extensors C7
 Finger flexors C8
 Finger abductors (little finger) T1

UEL
(Upper Extremity Left)

LEL
(Lower Extremity Left)

Hip flexors L2
 Knee extensors L3
 Ankle dorsiflexors L4
 Long toe extensors L5
 Ankle plantar flexors S1

(DAP) Deep anal pressure (Yes/No)

LEFT TOTALS
(MAXIMUM) (56) (56) (50)

MOTOR SUBSCORES **SENSORY SUBSCORES**

UER + UEL = UEMS TOTAL LER + LEL = LEMS TOTAL LTR + LTL = LT TOTAL PPR + PPL = PP TOTAL

MAX (25) (25) (50) MAX (25) (25) (50) MAX (56) (56) (112) MAX (56) (56) (112)

NEUROLOGICAL LEVELS **3. NEUROLOGICAL LEVEL OF INJURY (NLI)** **4. COMPLETE OR INCOMPLETE?** **5. ASIA IMPAIRMENT SCALE (AIS)**

1. SENSORY R L Incomplete = Key sensory or motor function in S4-5 (In complete/incomplete only) ZONE OF PARTIAL PRESERVATION SENSORY R L

2. MOTOR R L Most caudal level with any innervation MOTOR R L

This form may be copied freely but should not be altered without permission from the American Spinal Injury Association. REV 02/13

274x206mm (300 x 300 DPI)

セルフケア

- (1) 食事（切る、容器を開ける、飲み物を注ぐ、食べ物を口に運ぶ、飲み物の入ったコップをもつ）
 - 0. 静脈栄養または胃瘻が必要である、あるいは経口摂取において全介助を要する。
 - 1. 食べたり飲んだりすること、または補助器具の装着に部分介助を要する。
 - 2. 食べることは自立、補助器具を必要とするか、または食べ物を切ったり注いだりすること、容器の開閉にのみ解介助を要する。
 - 3. 食べることも飲むことも自立、介助や補助器具を必要としない。
- (2) 入浴（頭と体を石鹸でこすって洗い、乾かす、蛇口の開け閉め） A—上半身、B—下半身
 - A. 0. 全介助を要する。
 - 1. 部分介助を要する。
 - 2. 補助器具、または特定の環境（例えば、手すりや椅子）が整っていれば、自立して体を洗う。
 - 3. 自立して体を洗う。（通常、健常者なら用いることのない）補助器具や特定の環境設定は不要
 - B. 0. 全介助を要する。
 - 1. 部分介助を要する。
 - 2. 補助器具、または特定の環境が整っていれば、自立して体を洗う。
 - 3. 自立して体を洗う。補助器具や特定の環境設定は不要
- (3) 更衣（衣服、靴、常用している装具の着脱） A—上半身、B—下半身
 - A. 0. 全介助を要する。
 - 1. ボタン、ファスナー、ひものない衣服で部分介助を要する。
 - 2. ボタン、ファスナー、ひものない衣服であれば自立、補助器具と特定の環境設定、またはそのどちらかが必要。
 - 3. ボタン、ファスナー、ひものない衣服であれば自立、補助器具も特定の環境設定も不要、ボタン、ファスナー、ひもの扱いにだけ介助、補助器具、または特定の環境設定が必要。
 - 4.（衣類の種類を問わず）自立して着替える。補助器具も特定の環境設定も不要。
 - B. 0. 全介助を要する。
 - 1. ボタン、ファスナー、ひものない衣服で部分介助を要する。
 - 2. ボタン、ファスナー、ひものない衣服であれば自立、補助器具と特定の環境設定、またはそのどちらかが必要。
 - 3. ボタン、ファスナー、ひものない衣服であれば自立、補助器具も特定の環境設定も不要、ボタン、ファスナー、ひもの扱いにだけ介助、補助器具、または特定の環境設定が必要。
 - 4.（衣類の種類を問わず）自立して着替える。補助器具も特定の環境設定も不要。
- (4) 整容（手洗い、洗顔、歯磨き、整髪、髭剃り、化粧）
 - 0. 全介助を要する。
 - 1. 部分介助を要する。
 - 2. 補助器具があれば自立して整容動作をおこなう。
 - 3. 補助器具を用いずに自立して整容動作をおこなう。

小計 (0-20)

呼吸と排泄管理

- (5) 呼吸
 - 0. 気管チューブと持続的補助換気または間欠的補助換気が必要。
 - 1. 気管チューブを装着して自己呼吸、酸素を必要としたり、咳嗽時または気管チューブの管理に多大な介助を必要とする。
 - 2. 気管チューブを装着して自己呼吸、咳嗽時または気管チューブの管理に少しか介助を必要としない。
 - 3. 気管チューブなしで自己呼吸、酸素、咳嗽時の多大な介助、マスク（例：終末呼吸陽圧 PEEP）、または間欠的補助換気 (BiPAP) を必要とする。
 - 4. 気管チューブなしで自己呼吸、介助または咳嗽刺激を少しか必要としない。
 - 5. 介助も器具もなしで自己呼吸。

190x254mm (300 x 300 DPI)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

- (6) 排尿管理
 - 0. 留置カテーテル
 - 3. 残尿量 > 100cc. 不定期導尿または介助による間欠的導尿.
 - 6. 残尿量 > 100cc または間欠的の自己導尿. 集尿器¹をあてがう際の介助は必要.
 - 9. 間欠的の自己導尿. 集尿器を使用する. 器具をあてがう際の介助は不要.
 - 11. 間欠的の自己導尿. 導尿と導尿の間には失禁なし. 集尿器は使用しない.
 - 13. 残尿量 < 100cc. 集尿器のみ必要. 集尿器の取扱いには介助不要.
 - 15. 残尿量 < 100cc. 失禁なし. 集尿器を使用しない.
- (7) 排便管理
 - 0. 排便が不規則またはごく低頻度 (3 日に 1 回未満).
 - 5. 規則的ながら. (座薬を挿入するなどに) 介助を要する. 失敗はまれ (月 2 回未満).
 - 8. 規則的な排便で. 介助を要しない. 失敗はまれ (月 2 回未満).
 - 10. 規則的な排便で. 介助を要しない. 失敗はなし.
- (8) トイレの使用 (会陰部の清潔. 使用前後での衣服の扱い. ナプキンまたはおむつの使用)
 - 0. 全介助を要する.
 - 1. 部分介助を要する. 自分でお尻を拭けない.
 - 2. 部分介助を要する. 自立してお尻を拭ける.
 - 4. 自立してトイレを使用するも. 補助器具または特別な環境 (例: 手すり) が整っている必要あり.
 - 5. 自立してトイレを使用. 補助器具も特別な環境が整っている必要もない.

小計 (0-40)

移動 (室内とトイレ)

- (9) ベッド上での姿勢変換と褥瘡予防動作
 - 0. ベッド上で上半身の向きを変えること. 下半身の向きを変えること. 起き上がること. および車椅子上で
のフッシュアップのすべての動作に介助が必要. 補助器具の要否は問わないが. 電動器具は用いない.
 - 2. 介助なくできる動作が 1 つある.
 - 4. 介助なくできる動作が 2 つまたは 3 つある.
 - 6. ベッド上動作と除圧動作はすべて自立しておこなう.
- (10) 移乗: ベッド-車椅子 (車いすのブレーキ操作. フットレストの跳ね上げ. アームレストの脱着. 乗り移り. 足の持ち上げ)
 - 0. 全介助を要する.
 - 1. 部分介助. 監視. および補助器具 (例: スライディングボード) のすべて. もしくは. そのいずれかが必要.
 - 2. 自立 (または車椅子を必要としない).
- (11) 移乗: 車椅子-トイレ. 浴槽 (トイレ用車椅子¹ を使用している場合は. それへのからの乗り移り. 通常の車椅子を使用している場合は. 車椅子のブレーキ操作. フットレストの跳ね上げ. アームレストの脱着. 乗り移り. 足の持ち上げ)
 - 0. 全介助を要する.
 - 1. 部分介助. 監視. および補助器具 (例: 手すり) のすべて. もしくは. そのいずれかが必要.
 - 2. 自立 (または車椅子を必要としない).

移動 (屋内と屋外. 平らな所で)

- (12) 屋内の移動
 - 0. 全介助を要する.
 - 1. 電動車椅子を必要とするか. または手動車椅子を操作するのに部分介助を要する.
 - 2. 手動車椅子で自立して移動する.
 - 3. 歩行時に監視を必要とする (器具の要否は問わない).
 - 4. 歩行器または松葉杖で歩行 (大振り・小振り歩行).
 - 5. 松葉杖または T 字杖 2 本で歩行 (交互歩行).
 - 6. T 字杖 1 本で歩行.
 - 7. 下肢装具のみを必要とする.
 - 8. 歩行補助具なしで歩行.

190x254mm (300 x 300 DPI)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

- (13) まとまった距離の移動 (10~100m)
 - 0. 全介助を要する。
 - 1. 電動車椅子を必要とするか、または手動車椅子を操作するのに部分介助を要する。
 - 2. 手動車椅子で自立して移動する。
 - 3. 歩行時に監視を必要とする(器具の要否は問わない)。
 - 4. 歩行器または松葉杖で歩行(大振り・小振り歩行)。
 - 5. 松葉杖または T 字杖 2 本で歩行(交互歩行)。
 - 6. T 字杖 1 本で歩行。
 - 7. 下肢装具のみを必要とする。
 - 8. 歩行補助具なしで歩行。

- (14) 屋外の移動 (100m 以上)
 - 0. 全介助を要する。
 - 1. 電動車椅子を使用するか、または手動車椅子を操作するのに部分介助を要する。
 - 2. 手動車椅子で自立して移動する。
 - 3. 歩行時に監視を必要とする(器具の要否は問わない)。
 - 4. 歩行器または松葉杖で歩行(大振り・小振り歩行)。
 - 5. 松葉杖または T 字杖 2 本で歩行(交互歩行)。
 - 6. T 字杖 1 本で歩行。
 - 7. 下肢装具のみを必要とする。
 - 8. 歩行補助具なしで歩行。

- (15) 階段昇降
 - 0. 階段の上り下り不能。
 - 1. 人に支えられるか、またはその監視下で少なくとも 3 段は上り下りできる。
 - 2. 手すりにつかまったり、松葉杖や T 字杖を用いて少なくとも 3 段は上り下りできる。
 - 3. 支えも監視もなく少なくとも 3 段は上り下りできる。

- (16) 移乗: 車椅子一車 (車に近づく、車椅子のブレーキ操作、アームレストおよびフットレストの取り外し、車へのからの乗り移り、車椅子の積み降ろし)
 - 0. 全介助を要する。
 - 1. 部分介助、監視、および補助器具のすべて、もしくはいずれかを必要とする。
 - 2. 自立して移乗する。補助器具を必要としない(または車椅子を必要としない)。

- (17) 移乗: 床一車椅子
 - 0. 介助を要する。
 - 1. 補助器具の有無にかかわらず、自立して移乗する(または車椅子を必要としない)。

小計(0-40)

SCIM 合計スコア(0-100)

訳者注
 1. 夜間のみ BPAP を使用している場合も 0 点とする
 2. 原書では external drainage instrument、体外からあててるのみが非圧力器具集束器のこと指す。例えば、コンドーム型集束器、しびんなどが含まれる。尿道や膀胱に挿入するカテーテルは含まれない
 3. ベッド横やひもなどを使ってもよい
 4. 原書では toilet wheelchair、便器や浴槽に移乗することなく、乗車したまま洋式便器が使用でき、シャワー浴にも使える車椅子のこと。介助型と自立型がある。わが国ではトイレ兼用シャワーキヤリー(介助型)が用いられることがある
 SCIM (Version 3.0) 日本語版 朝川律之・黒川真希子・出田良輔・星宇明光訳
 [Translated by permission from Dr. Amiram Catz, Loewenstein Rehabilitation Hospital, Raanana, Israel]
 [Reprinted by permission from Macmillan Publishers Ltd. Spinal cord 40: 396-407, copyright 2002]

190x254mm (300 x 300 DPI)

以下のそれぞれの項目の一つの四角に（このように☐）印をつけて、あなた自身の今日の健康状態を最も良く表している記述を示して下さい。

移動の程度

歩き回るのに問題はない

歩き回るのにいくらか問題がある

ベッド（床）に寝たきりである

身の回りの管理

身の回りの管理に問題はない

洗面や着替えを自分でするのにいくらか問題がある

洗面や着替えを自分でできない

ふだんの活動（例：仕事、勉強、家事、家族・余暇活動）

ふだんの活動を行うのに問題はない

ふだんの活動を行うのにいくらか問題がある

ふだんの活動を行うことができない

痛み／不快感

痛みや不快感はない

中程度の痛みや不快感がある

ひどい痛みや不快感がある

不安／ふさぎ込み

不安でもふさぎ込んでもいない

中程度に不安あるいはふさぎ込んでいる

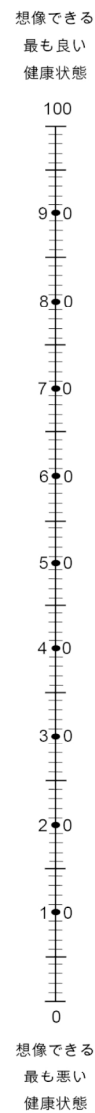
ひどく不安あるいはふさぎ込んでいる

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

健康状態がどのくらい良いか悪いかを表わしてもらうために、(温度計に似たような) 目盛を描きました。目盛には、あなたの想像できる最も良い状態として 100、あなたの想像できる最も悪い状態として 0 が付けられています。

あなたの今日の健康状態がどのくらい良いか悪いかを、あなたの考えでこの目盛上に示して下さい。下の「あなたの今日の健康状態」と書かれた四角から、あなたの現在の健康状態のよし悪しを示す目盛上の点まで、線を引いて下さい。

**あなたの
今日の
健康状態**





CONSORT 2010 checklist of information to include when reporting a randomised trial*

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a randomised trial in the title	1
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	3
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale	4-5
	2b	Specific objectives or hypotheses	6
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	6
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	N/A
Participants	4a	Eligibility criteria for participants	7
	4b	Settings and locations where the data were collected	11
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	6-7
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	6-7
	6b	Any changes to trial outcomes after the trial commenced, with reasons	N/A
Sample size	7a	How sample size was determined	8
	7b	When applicable, explanation of any interim analyses and stopping guidelines	N/A
Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	6
	8b	Type of randomisation; details of any restriction (such as blocking and block size)	6
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	8
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	6
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those	8

		assessing outcomes) and how	
	11b	If relevant, description of the similarity of interventions	N/A
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	8-9
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	N/A
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	N/A
	13b	For each group, losses and exclusions after randomisation, together with reasons	N/A
Recruitment	14a	Dates defining the periods of recruitment and follow-up	N/A
	14b	Why the trial ended or was stopped	N/A
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	N/A
Numbers analysed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	N/A
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	N/A
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	N/A
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	N/A
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	N/A
Discussion			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	N/A
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	N/A
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	N/A
Other information			
Registration	23	Registration number and name of trial registry	3
Protocol	24	Where the full trial protocol can be accessed, if available	3
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	11

*We strongly recommend reading this statement in conjunction with the CONSORT 2010 Explanation and Elaboration for important clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological treatments, herbal interventions, and pragmatic trials. Additional extensions are forthcoming: for those and for up to date references relevant to this checklist, see www.consort-statement.org.

BMJ Open

Study Protocol for the G-SPIRIT trial: A Randomized, Placebo-Controlled, Double-blinded Phase 3 Trial of Granulocyte Colony Stimulating Factor-Mediated Neuroprotection for Acute Spinal Cord Injury

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-019083.R3
Article Type:	Protocol
Date Submitted by the Author:	15-Dec-2017
Complete List of Authors:	<p>Koda, Masao; G-SPIRIT Study Group; University of Tsukuba, Department of Orthopedic Surgery Hanaoka, Hideki; G-SPIRIT Study Group; Chiba University Hospital, Clinical Research Center Sato, Takatoshi; G-SPIRIT Study Group; Chiba University Hospital, Clinical Research Center Fujii, Yasuhisa; G-SPIRIT Study Group; Chiba University Hospital, Clinical Research Center Hanawa, Michiko; G-SPIRIT Study Group; Chiba University Hospital, Clinical Research Center Takahashi, Sho; G-SPIRIT Study Group; Chiba University Hospital, Clinical Research Center Furuya, Takeo; G-SPIRIT Study Group; Graduate School of Medicine, Chiba University, Department of Orthopaedic Surgery Ijima, Yasushi; G-SPIRIT Study Group; Graduate School of Medicine, Chiba University, Department of Orthopaedic Surgery Saito, Junya; G-SPIRIT Study Group; Graduate School of Medicine, Chiba University, Department of Orthopaedic Surgery Kitamura, Mitsuhiro; G-SPIRIT Study Group; Graduate School of Medicine, Chiba University, Department of Orthopaedic Surgery Ohtori, Seiji; G-SPIRIT Study Group; Graduate School of Medicine, Chiba University, Department of Orthopaedic Surgery Matsumoto, Yukei; G-SPIRIT Study Group; University of Tsukuba, Department of Orthopedic Surgery Abe, Tetsuya; G-SPIRIT Study Group; University of Tsukuba, Department of Orthopedic Surgery Watanabe, Kei; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Hirano, Toru; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Ohashi, Masayuki; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Shoji, Hirokazu; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Mizouchi, Tatsuki; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Takahashi, Ikuko; G-SPIRIT Study Group; Niigata University Graduate School of Medicine and Dental Sciences, Department of Orthopedic Surgery Kawahara, Norio; G-SPIRIT Study Group; Kanazawa Medical University,</p>

1	
2	
3	
4	Orthopaedic Surgery
5	Kawaguchi, Masahito; G-SPIRIT Study Group; Kanazawa Medical
6	University, Orthopaedic Surgery
7	Orita, Yugo; G-SPIRIT Study Group; Kanazawa Medical University,
8	Orthopaedic Surgery
9	Sasamoto, Takeshi; G-SPIRIT Study Group; Kanazawa Medical University,
10	Orthopaedic Surgery
11	Yoshioka, Masahito; G-SPIRIT Study Group; Kanazawa Medical University,
12	Orthopaedic Surgery
13	Fujii, Masafumi; G-SPIRIT Study Group; Kanazawa Medical University,
14	Orthopaedic Surgery
15	Yonezawa, Katsutaka; G-SPIRIT Study Group; Kanazawa Medical
16	University, Orthopaedic Surgery
17	Soma, Daisuke; G-SPIRIT Study Group; Kanazawa Medical University,
18	Orthopaedic Surgery
19	Taneichi, Hiroshi; G-SPIRIT Study Group; Dokkyo Ika Daigaku, Department
20	of Orthopedic Surgery
21	Takeuchi, Daisaku; G-SPIRIT Study Group; Dokkyo Ika Daigaku,
22	Department of Orthopedic Surgery
23	Inami, Satoshi; G-SPIRIT Study Group; Dokkyo Ika Daigaku, Department
24	of Orthopedic Surgery
25	Moridaira, Hiroshi; G-SPIRIT Study Group; Dokkyo Ika Daigaku,
26	Department of Orthopedic Surgery
27	Ueda, Haruki; G-SPIRIT Study Group; Dokkyo Ika Daigaku, Department of
28	Orthopedic Surgery
29	Asano, Futoshi; G-SPIRIT Study Group; Dokkyo Ika Daigaku, Department
30	of Orthopedic Surgery
31	Shibao, Yosuke; G-SPIRIT Study Group; Dokkyo Ika Daigaku, Department
32	of Orthopedic Surgery
33	Aita, Ikuo; G-SPIRIT Study Group; Tsukuba Medical Center Byoin,
34	Department of Orthopedic Surgery
35	Takeuchi, Yosuke; G-SPIRIT Study Group; Tsukuba Medical Center Byoin,
36	Department of Orthopedic Surgery
37	Mimura, Masaya; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
38	Department of Orthopedic Surgery
39	Shimbo, Jun; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
40	Department of Orthopedic Surgery
41	Someya, Yukio; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
42	Department of Orthopedic Surgery
43	Ikenoue, Sumio; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
44	Department of Orthopedic Surgery
45	Sameda, Hiroaki; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
46	Department of Orthopedic Surgery
47	Takase, Kan; G-SPIRIT Study Group; Funabashi Shiritsu Iryo Center,
48	Department of Orthopedic Surgery
49	Ikeda, Yoshikazu; G-SPIRIT Study Group; Chiba Rosai Byoin, Department
50	of Orthopedic Surgery
51	Nakajima, Fumitake; G-SPIRIT Study Group; Chiba Rosai Byoin,
52	Department of Orthopedic Surgery
53	Hashimoto, Mitsuhiro; G-SPIRIT Study Group; Chiba Rosai Byoin,
54	Department of Orthopedic Surgery
55	Ozawa, Tomoyuki; G-SPIRIT Study Group; Chiba Rosai Byoin, Department
56	of Orthopedic Surgery
57	Hasue, Fumio; G-SPIRIT Study Group; Kimitsu Chuo Byoin, Department of
58	Orthopedic Surgery
59	Fujiyoshi, Takayuki; G-SPIRIT Study Group; Kimitsu Chuo Byoin,
60	Department of Orthopedic Surgery
	Kamiya, Koshiro; G-SPIRIT Study Group; Kimitsu Chuo Byoin, Department
	of Orthopedic Surgery
	Watanabe, Masahiko; G-SPIRIT Study Group; Tokai Daigaku Igakubu
	Seikei Gekagaku, Department of Orthopedic Surgery

1	
2	
3	
4	Katoh, Hiroyuki; G-SPIRIT Study Group; Tokai Daigaku - Isehara Campus,
5	Department of Orthopedic Surgery
6	Matsuyama, Yukihiro; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
7	Department of Orthopedic Surgery
8	Yamato, Yu; G-SPIRIT Study Group; Hamamatsu Ika Daigaku, Department
9	of Orthopedic Surgery
10	Togawa, Daisuke; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
11	Department of Orthopedic Surgery
12	Hasegawa, Tomohiko; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
13	Department of Orthopedic Surgery
14	Kobayashi, Sho; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
15	Department of Orthopedic Surgery
16	Yoshida, Go; G-SPIRIT Study Group; Hamamatsu Ika Daigaku, Department
17	of Orthopedic Surgery
18	Oe, Shin; G-SPIRIT Study Group; Hamamatsu Ika Daigaku, Department of
19	Orthopedic Surgery
20	Banno, Tomohiro; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
21	Department of Orthopedic Surgery
22	Arima, Hideyuki; G-SPIRIT Study Group; Hamamatsu Ika Daigaku,
23	Department of Orthopedic Surgery
24	Akeda, Koji; G-SPIRIT Study Group; Mie Daigaku Daigakuin Igakukei
25	Kenkyuka Igakubu, Department of Orthopedic Surgery
26	Kawamoto, Eiji; G-SPIRIT Study Group; Mie Daigaku Daigakuin Igakukei
27	Kenkyuka Igakubu, Department of Orthopedic Surgery
28	Imai, Hiroshi; G-SPIRIT Study Group; Mie Daigaku Daigakuin Igakukei
29	Kenkyuka Igakubu, Department of Orthopedic Surgery
30	Sakakibara, Toshihiko; G-SPIRIT Study Group; Mie Daigaku Daigakuin
31	Igakukei Kenkyuka Igakubu, Department of Orthopedic Surgery
32	Sudo, Akihiro ; G-SPIRIT Study Group; Mie Daigaku Daigakuin Igakukei
33	Kenkyuka Igakubu, Department of Orthopedic Surgery
34	Ito, Yasuo; G-SPIRIT Study Group; Kobe Sekijuji Byoin, Department of
35	Orthopedic Surgery
36	Kikuchi, Tsuyoshi; G-SPIRIT Study Group; Kobe Sekijuji Byoin, Department
37	of Orthopedic Surgery
38	Osaki, Shuhei; G-SPIRIT Study Group; Kobe Sekijuji Byoin, Department of
39	Orthopedic Surgery
40	Tanaka, Nobuhiro; G-SPIRIT Study Group; Hiroshima Daigaku Igakubu
41	Daigakuin Ishiyaku Hokengaku Kenkyuka, Department of Orthopedic
42	Surgery
43	Nakanishi, Kazuyoshi; G-SPIRIT Study Group; Hiroshima Daigaku Igakubu
44	Daigakuin Ishiyaku Hokengaku Kenkyuka, Department of Orthopedic
45	Surgery
46	Kamei, Naosuke; G-SPIRIT Study Group; Hiroshima Daigaku Igakubu
47	Daigakuin Ishiyaku Hokengaku Kenkyuka, Department of Orthopedic
48	Surgery
49	Kotaka, Shinji; G-SPIRIT Study Group; Hiroshima Daigaku Igakubu
50	Daigakuin Ishiyaku Hokengaku Kenkyuka, Department of Orthopedic
51	Surgery
52	Baba, Hideo; G-SPIRIT Study Group; Nagasaki Rosai Byoin, Department of
53	Orthopedic Surgery
54	Okudaira, Tsuyoshi; G-SPIRIT Study Group; Nagasaki Rosai Byoin,
55	Department of Orthopedic Surgery
56	Hiroaki, Konishi; G-SPIRIT Study Group; Nagasaki Rosai Byoin,
57	Department of Orthopedic Surgery
58	Yamaguchi, Takayuki; G-SPIRIT Study Group; Nagasaki Rosai Byoin,
59	Department of Orthopedic Surgery
60	Ito, Keigo; G-SPIRIT Study Group; Chubu Rosai Byoin, Department of
	Orthopedic Surgery
	Katayama, Yoshito; G-SPIRIT Study Group; Chubu Rosai Byoin,
	Department of Orthopedic Surgery
	Matsumoto, Taro; G-SPIRIT Study Group; Chubu Rosai Byoin, Department

	<p>of Orthopedic Surgery Matsumoto, Tomohiro; G-SPIRIT Study Group; Chubu Rosai Byoin, Department of Orthopedic Surgery Idota, Masaru; G-SPIRIT Study Group; Chubu Rosai Byoin, Department of Orthopedic Surgery Kanno, Haruo; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Aizawa, Toshimi; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Hashimoto, Ko; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Eto, Toshimitsu; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Sugaya, Takehiro; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Matsuda, Michiharu; G-SPIRIT Study Group; Tohoku University School of Medicine, Department of Orthopedic Surgery Fushimi, Kazunari; G-SPIRIT Study Group; Gifu Daigaku Igakubu Daigakuin Igaku Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Nozawa, Satoshi; G-SPIRIT Study Group; Gifu Daigaku Igakubu Daigakuin Igaku Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Iwai, Chizuo; G-SPIRIT Study Group; Gifu Daigaku Igakubu Daigakuin Igaku Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Taguchi, Toshihiko; G-SPIRIT Study Group; Yamaguchi Daigaku Igakubu Daigakuin Igakukei Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Kanchiku, Tsukasa; G-SPIRIT Study Group; Yamaguchi Daigaku Igakubu Daigakuin Igakukei Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Suzuki, Hidenori; G-SPIRIT Study Group; Yamaguchi Daigaku Igakubu Daigakuin Igakukei Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Nishida, Norihiro; G-SPIRIT Study Group; Yamaguchi Daigaku Igakubu Daigakuin Igakukei Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Funaba, Masahiro; G-SPIRIT Study Group; Yamaguchi Daigaku Igakubu Daigakuin Igakukei Kenkyuka Seikei Gekagaku, Department of Orthopedic Surgery Yamazaki, Masashi; G-SPIRIT Study Group; University of Tsukuba, Department of Orthopedic Surgery</p>
Primary Subject Heading:	Neurology
Secondary Subject Heading:	Medical management
Keywords:	Neurological injury < NEUROLOGY, Spine < ORTHOPAEDIC & TRAUMA SURGERY, Clinical trials < THERAPEUTICS

SCHOLARONE™
 Manuscripts

1
2
3
4
5
6
7
8
9

Study Protocol for the G-SPIRIT trial: A Randomized, Placebo-Controlled, Double-blinded Phase 3 Trial of Granulocyte Colony Stimulating Factor-Mediated Neuroprotection for Acute Spinal Cord Injury

10
11
12
13
14
15
16

Corresponding Author: Masao Koda

1-1-1 Tennodai, Tsukuba City, Ibaraki 3058575, Japan

e-mail: masaokod@gmail.com, tel: 81-29-853-3219

17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Authors: Masao Koda^{1,2}, Hideki Hanaoka^{1,3}, Takatoshi Sato^{1,3}, Yasuhisa Fujii^{1,3}, Michiko Hanawa^{1,3}, Sho Takahashi^{1,3}, Takeo Furuya^{1,4}, Yasushi Ijima^{1,4}, Junya Saito^{1,4}, Mitsuhiro Kitamura^{1,4}, Seiji Ohtori^{1,4}, Yukei Matsumoto^{1,2}, Tetsuya Abe^{1,2}, Kei Watanabe^{1,5}, Toru Hirano^{1,5}, Masayuki Ohashi^{1,5}, Hirokazu Shoji^{1,5}, Tatsuki Mizouchi^{1,5}, Ikuko Takahashi^{1,5}, Norio Kawahara^{1,6}, Masahito Kawaguchi^{1,6}, Yugo Orita^{1,6}, Takeshi Sasamoto^{1,6}, Masahito Yoshioka^{1,6}, Masafumi Fujii^{1,6}, Katsutaka Yonezawa^{1,6}, Daisuke Soma^{1,6}, Hiroshi Taneichi^{1,7}, Daisaku Takeuchi^{1,7}, Satoshi Inami^{1,7}, Hiroshi Moridaira^{1,7}, Haruki Ueda^{1,7}, Futoshi Asano^{1,7}, Yosuke Shibao^{1,7}, Ikuo Aita^{1,8}, Yosuke Takeuchi^{1,8}, Masaya Mimura^{1,9}, Jun Shimbo^{1,9}, Yukio Someya^{1,9}, Sumio Ikenoue^{1,9}, Hiroaki Sameda^{1,9}, Kan Takase^{1,9}, Yoshikazu Ikeda^{1,10}, Fumitake Nakajima^{1,10}, Mitsuhiro Hashimoto^{1,10}, Tomoyuki Ozawa^{1,10}, Fumio Hasue^{1,11}, Takayuki Fujiyoshi^{1,11}, Koshiro Kamiya^{1,11}, Masahiko Watanabe^{1,12}, Hiroyuki Katoh^{1,12}, Yukihiro Matsuyama^{1,13}, Yu Yamamoto^{1,13}, Daisuke Togawa^{1,13}, Tomohiko Hasegawa^{1,13}, Sho Kobayashi^{1,13}, Go Yoshida^{1,13}, Shin Oe^{1,13}, Tomohiro Banno^{1,13}, Hideyuki Arima^{1,13}, Koji Akeda^{1,14}, Eiji Kawamoto^{1,14}, Hiroshi Imai^{1,14}, Toshihiko Sakakibara^{1,14}, Akihiro Sudo^{1,14}, Yasuo Ito^{1,15}, Tsuyoshi Kikuchi^{1,15}, Shuheii Osaki^{1,15}, Nobuhiro Tanaka^{1,16}, Kazuyoshi Nakanishi^{1,16}, Naosuke Kamei^{1,16}, Shinji Kotaka^{1,16}, Hideo Baba^{1,17}, Tsuyoshi Okudaira^{1,17}, Hiroaki Konishi^{1,17}, Takayuki Yamaguchi^{1,17}, Keigo Ito^{1,18}, Yoshito Katayama^{1,18}, Taro Matsumoto^{1,18}, Tomohiro Matsumoto^{1,18}, Masaru Idota^{1,18}, Haruo Kanno^{1,19}, Toshimi Aizawa^{1,19}, Ko Hashimoto^{1,19}, Toshimitsu Eto^{1,19}, Takehiro Sugaya^{1,19}, Michiharu Matsuda^{1,19}, Kazunari Fushimi^{1,20}, Satoshi Nozawa^{1,20}, Chizuo Iwai^{1,20}, Toshihiko Taguchi^{1,21}, Tsukasa Kanchiku^{1,21}, Hidenori Suzuki^{1,21}, Norihiro Nishida^{1,21}, Masahiro Funaba^{1,21}, Masashi Yamazaki^{1,2}

1
2
3
4
5
6 Affiliations

7 ¹G-SPIRIT Study Group is consisted by Nineteen major hospitals in Japan constituting the
8 G-SPIRIT study group
9

10 ²Department of Orthopedic Surgery, University of Tsukuba, Ibaraki

11 ³Clinical Research Center, Chiba University Hospital, Chiba

12 ⁴Department of Orthopedic Surgery, Chiba University Graduate School of Medicine, Chiba

13 ⁵Department of Orthopedic Surgery, Niigata University Graduate School of Medicine and
14 Dental Sciences, Niigata
15

16 ⁶Department of Orthopedic Surgery, Kanazawa Medical University, Ishikawa

17 ⁷Department of Orthopedic Surgery, Dokkyo Medical University, Tochigi

18 ⁸Department of Orthopedic Surgery, Tsukuba Medical Center, Ibaraki

19 ⁹Department of Orthopedic Surgery, Funabashi Municipal Medical Center, Chiba

20 ¹⁰Department of Orthopedic Surgery, Chiba Rosai Hospital, Chiba

21 ¹¹Department of Orthopedic Surgery, Kimitsu Chuo Hospital, Chiba

22 ¹²Department of Orthopedic Surgery, Tokai University School of Medicine, Kanagawa

23 ¹³Department of Orthopedic Surgery, Hamamatsu University School of Medicine, Shizuoka

24 ¹⁴Department of Orthopedic Surgery, Graduate School of Medicine, Mie University, Mie

25 ¹⁵Department of Orthopedic Surgery, Kobe Red Cross Hospital, Hyogo

26 ¹⁶Department of Orthopedic Surgery, Graduate School of Biomedical Sciences, Hiroshima
27 University, Hiroshima

28 ¹⁷Department of Orthopedic Surgery, Nagasaki Rosai Hospital, Nagasaki

29 ¹⁸Department of Orthopedic Surgery, Chubu Rosai Hospital, Aichi

30 ¹⁹Department of Orthopedic Surgery, Tohoku University School of Medicine, Miyagi

31 ²⁰Department of Orthopedic Surgery, Gifu University School of Medicine, Gifu

32 ²¹Department of Orthopedic Surgery, Yamaguchi University Graduate School of Medicine,
33 Yamaguchi
34

35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52 Word Count: 2516
53
54
55
56
57

Abstract

Introduction: Granulocyte Colony Stimulating Factor (G-CSF) is generally used for neutropenia. Previous experimental studies revealed that G-CSF promoted neurological recovery after spinal cord injury (SCI). Next we moved to early phase of clinical trials. In a phase 1/2a trial, no adverse events were observed. Next, we conducted a non-randomized, non-blinded, comparative trial, which suggested the efficacy of G-CSF for promoting neurological recovery. Based on those results, we are now performing a phase 3 trial.

Methods and Analysis: The objective of this study is to evaluate the efficacy of G-CSF for acute SCI. The study design is a prospective, multicenter, randomized, double-blinded, placebo-controlled comparative study. The current trial includes cervical SCI (severity of American Spinal Injury Association (ASIA) Impairment Scale B/C) within 48 hours after injury. Patients are randomly assigned to G-CSF and placebo groups. The G-CSF group is administered 400 $\mu\text{g}/\text{m}^2/\text{d}\times 5\text{d}$ of G-CSF in normal saline via intravenous infusion for 5 consecutive days. The placebo group is similarly administered a placebo. Our primary endpoint is changes in ASIA motor scores from baseline to 3 months. Each group includes 44 patients (88 total patients). This trial is funded by the Center for Clinical Trials, Japan Medical Association.

Ethics and Dissemination: The study was approved by the Institutional Review Board of each institution and will be conducted according to the principles of the World Medical Association Declaration of Helsinki and in accordance with the Japanese Medical Research Involving Human Subjects Act and other guidelines, regulations and Acts. Results of the clinical study will be submitted to the head of the respective clinical study site as a report after conclusion of the clinical study by the sponsor-investigator. Even if the results are not favorable despite conducting the clinical study properly, the data will be published as a paper.

Registration: UMIN000018752

<https://upload.umin.ac.jp/cgi-open-bin/ctr/ctr.cgi?function=brows&action=brows&type=summary&recptno=R000021694&language=J>

Protocol version: Ver. 5.0 (2016/10/20)

Strengths and Limitations of This Study

Strengths

- ✓ Novel drug therapy for acute spinal cord injury is much-needed.
- ✓ Randomized, placebo-controlled, double-blinded design can eliminate bias.

Limitations

- ✓ Acute spinal cord injury patients are difficult to recruit to the trial.
- ✓ Patient's neurological status in acute phase is unstable, possibly resulting in dispersion of the patient's background.

- 1
2
3
4
5 ✓ Concealment must be performed very strictly because G-CSF apparently increases
6 white blood cell count.
7
8

9 **Introduction**

10 Spinal cord injury (SCI) is a devastating injury by which the patient can suffer from
11 long-lasting severe sequelae including palsy of extremities, sensory disturbance,
12 bowel/bladder/sexual dysfunction, and neuropathic pain. Conceptually, SCI is divided into
13 two chronological phases: a primary and a secondary phase. Primary injury is mechanical
14 damage to spinal cord tissue itself caused by fracture and/or dislocation or compression.
15 Secondary injury is triggered by the primary injury and is a biological reaction of the spinal
16 cord, which includes ischemia, hemorrhage, excitotoxicity, hyperpermeability, and
17 inflammation¹. Because secondary injury can be the main target of treatment, extensive
18 laboratory and clinical investigation of neuroprotection is needed to manage secondary
19 injury².
20
21
22
23
24
25
26
27

28 To date, the only approved neuroprotective therapy for SCI is massive
29 methylprednisolone sodium succinate (MPSS) therapy based on the NASCIS 2 study³.
30 However, recent reports revealed that MPSS shows only a modest effect for SCI. In
31 addition, several reports have described adverse events induced by MPSS for SCI including
32 infections (pneumonia, urinary tract infection) and gastrointestinal disorders (gastric ulcer,
33 etc.)⁴. Therefore, the use of MPSS for SCI has become controversial⁵. Accordingly, a new
34 therapeutic drug for SCI is desirable.
35
36
37
38
39

40 Granulocyte colony-stimulating factor (G-CSF, generic name: filgrastim) is a growth
41 factor that affects the hematopoietic system, promoting differentiation, proliferation, and
42 survival of granulocytes⁶. Clinically, in Japan, G-CSF is administered to patients with
43 leukopenia, and to peripheral stem cell transplantation donors, G-CSF is administered to
44 mobilize hematopoietic stem cells into the peripheral blood⁷. In the central nervous system,
45 G-CSF has properties to mobilize the movement of bone marrow cells into the brain⁸ and
46 spine, and in a stroke model, has shown neuroprotective properties⁹. In other countries,
47 clinical studies of the effects of G-CSF in cerebral infarction have been reported¹⁰.
48
49
50
51
52
53

54 To prove the hypothesis that G-CSF has neuroprotective properties against SCI, G-CSF
55
56
57

1
2
3
4
5 was administered to rat and mouse animal models of spinal cord injury, and hind limb
6 function improved significantly after administration of G-CSF. Further investigations into
7 the mechanism of action of G-CSF in SCI were conducted. Data obtained to date identify
8 the following properties of G-CSF: [1] mobilization of bone marrow-derived stem cells
9 causing their biointegration at the site of SCI¹¹, [2] direct inhibition of nerve cell death¹²,
10 [3] protection of the myelin sheath by inhibiting oligodendrocyte cell death¹³, [4] inhibition
11 of inflammatory cytokine expression (TNF- α , IL-1 β)¹³, and [5] promotion of
12 neovascularization¹⁴. These properties suggest that G-CSF has a neuroprotective effect in
13 acute SCI.
14
15
16
17
18
19
20

21 Based on these properties, a phase 1/2a clinical study was conducted where the main
22 objective was to confirm the safety and feasibility of G-CSF for treatment of patients with
23 acute SCI¹⁵. This study was an open-label, dose-titrating study with no control group. As
24 the initial step, 5 patients were given 5 $\mu\text{g}/\text{kg}/\text{day}$ of G-CSF for 5 consecutive days by i.v.
25 infusion, and as the second step, 11 patients were given 10 $\mu\text{g}/\text{kg}/\text{day}$ of G-CSF for 5
26 consecutive days by i.v. infusion. No serious adverse events were noted, and the safety of
27 G-CSF administration in patients with acute SCI was confirmed¹⁵.
28
29
30
31
32

33 As a next step, to validate the efficacy of G-CSF in neuroprotective treatment, a
34 multicenter, prospective, nonrandomized, nonblinded, comparative control study (phase 2b
35 clinical trial) was conducted¹⁶. Based on the results of the previous phase 1/2a clinical trial,
36 the dosage and duration of treatment with G-CSF in this study was 10 $\mu\text{g}/\text{kg}/\text{day}$ for 5
37 consecutive days. Patients with acute cervical SCI (within 48 h of injury) were registered in
38 the clinical trial and allocated to either the G-CSF group (G-CSF 10 $\mu\text{g}/\text{kg}/\text{day} \times 5$ days i.v.
39 infusion) or control group (no G-CSF administration) at each treatment facility. A total of
40 19 patients in the G-CSF group and 26 patients in the control group were observed for 3
41 months or longer. American Spinal Injury Association (ASIA) motor score (motor: 0 to 100
42 points) was compared between the groups. ASIA motor scores were 26.1 ± 18.9 in the
43 G-CSF group and 12.2 ± 14.7 in the control group showing a significant improvement of
44 motor paralysis in the G-CSF group ($p < 0.01$). In addition, in cases that could be followed
45 for 1 year or longer, a significant improvement of ASIA motor score was observed in the
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5 G-CSF group¹⁶.
6

7 Based on results of these preclinical and early phase clinical trials, we are now
8 conducting a phase 3 trial.
9

10 11 12 *Specific Objective* 13

14 The objective of this study is to evaluate the efficacy of G-CSF for improving motor
15 paralysis in acute SCI.
16

17 18 19 **Methods and Analysis** 20

21 *Design of the study* 22

23 The study design of the current trial is a prospective, multicenter, randomized,
24 double-blinded, placebo-controlled comparative study.
25
26

27 28 *Study Procedures* 29

30 The study outline is shown in Figure. Patients will be randomly assigned to G-CSF and
31 placebo groups. A central registration system will be used for dynamic randomization into
32 the investigational treatment group (G-CSF) and control group (placebo) based on age at
33 registration (16–64 years of age, or 65–84 years of age) and severity of paralysis (AIS B or
34 C) at 48 h after injury. With or without the surgical stabilization and/or decompression was
35 not included in stratification. Initially, screened patients with severity AIS B/C will be
36 tentatively enrolled. Initial screening of the patients include clinical laboratory test, imaging
37 studies including X-ray, magnetic resonance imaging and computed tomography, and
38 neurological/functional evaluations.
39

40 Neurological re-assessment will be performed 48±4 hours after SCI and the patients
41 who will recover to severity AIS D will be excluded. The patients with severity AIS B/C at
42 neurological re-assessment 48±4 hours after SCI will be enrolled and randomly allocated to
43 either the investigational treatment group (G-CSF) or control group (placebo) in a 1 to 1
44 ratio. The subject registration center uses a program based on an appropriate computer
45 algorithm to allocate patients into groups. The first dose of investigative drugs will be
46
47
48
49
50
51
52
53
54
55
56
57

1
2
3
4
5 administered to the patients after re-assessment of neurological status and enrollment 48±4
6 hours after SCI.
7

8
9 The G-CSF group will be administered 400 µg/m²/d × 5d of G-CSF in normal saline via
10 intravenous infusion for 5 consecutive days. The placebo group will be similarly
11 administered a placebo. The first dose of investigative drugs will be administered to the
12 patients 48±4 hours after SCI. The dosing schedule will be once a day in every morning
13 (9-10 AM) for consecutive 5 days even in case that the first dosing was performed at night
14 because of restriction on practices. Investigational drugs including both G-CSF and placebo
15 will be stored in refrigerator which will be kept between 1- 6°C and has temperature-logger
16 in pharmacies in each participating institutes. The investigational drugs is packaged in
17 ampule with label only printed as serial numbers, ten ampule is packed in one box with label
18 only printed serial numbers. Web-based allocation system will show the serial number of
19 investigational drug which must be used to respective patients to ensure blinding.
20
21
22
23
24
25
26
27

28 We decided dosage of drug based on our previous non-randomized early phase clinical
29 studies. On phase 1/2a clinical study, of which study design was open-label, dose-titrating
30 study with no control group, SCI patients who were administered 10µg/kg/day G-CSF for 5
31 days showed marked elevation of white blood cell number (reached nearly 50000/µl, of
32 which WBC number might cause adverse effects of G-CSF) during G-CSF administration¹⁵.
33 Therefore we decided to withdraw additional titration. In addition, next phase of clinical
34 study, of which design was multicenter, prospective, nonrandomized, nonblinded,
35 comparative control study, showed suggestive efficacy of G-CSF (10 µg/kg/d for 5 days)
36 for acute SCI¹⁶. Based on those results, we finally decided the dosage of G-CSF as 10
37 µg/kg/d × 5d for 5 days. In the current clinical trial, the dosage of G-CSF is written as 400
38 µg/m²/d (= 10 µg/kg/d) according to the Japanese Pharmaceutical and Medical Device
39 Agency (PMDA)'s instruction for consolidation with product labeling.
40
41
42
43
44
45
46
47
48

49 We decided to 48hours after SCI as the therapeutic time window because our previous
50 multicenter, prospective, nonrandomized, nonblinded, comparative control study, which
51 recruited SCI patients within 48 hours after injury, showed that there was no significant
52 difference in neurological outcome between the patient administered G-CSF very early
53
54
55
56
57

1
2
3
4
5 after the injury and 48 hours after injury¹⁶.
6

7 Allocation will be concealed between blinded evaluators of efficacy/safety and those
8 for laboratory data, as G-CSF markedly increases white blood cell counts that can reveal
9 patient treatment.
10

11
12 Our primary endpoint is changes in ASIA motor scores (international standards for
13 neurological classification of spinal cord injury (ISNSCI)¹⁷ suppl. Figure 1) from baseline
14 to 3 months calculated as follows: 3-month ASIA motor score change = 3-month ASIA
15 motor score – pretreatment ASIA motor score. To maintain consistency of neurological
16 assessment among the each evaluators, attending lecture and e-learning (in website of
17 International Spinal Cord Society: <http://www.elearnsoci.org/>) of ASIA/ISNSCI scoring
18 system is mandatory for every investigators participating to the present trial.
19
20

21
22 Secondary endpoints are as follows. [1] Change in ASIA motor scores¹⁷ at 6 months
23 and 12 months after G-CSF administration compared with pretreatment. [2] Changes in
24 sensory paralysis over time: change in ASIA sensory scores at 3 months, 6 months, and 12
25 months after G-CSF administration compared with pretreatment. [3] Severity of functional
26 compromise because of paralysis: AIS before administration and at 3, 6, and 12 months
27 after administration of G-CSF. [4] Percentage of responders: percentage of patients whose
28 AIS improved by 1 grade or more at 3, 6, and 12 months after administration compared
29 with before administration of G-CSF. [5] Neurological level of injury (NLI): percentage of
30 patients whose NLI decreased by 1 grade or more at 3, 6, or 12 months after administration
31 of G-CSF compared with pretreatment. [6] SCIM¹⁸: change in SCIM scores at 3, 6, and 12
32 months after G-CSF administration compared with pretreatment [7] EQ-5D¹⁹: measured
33 EQ-5D efficacy scores at 3, 6, and 12 months after G-CSF.
34
35

36
37 To strengthen the analysis, more strict blindness of assessment by the evaluator for
38 outcome measures is ideal. Therefore every prior score/measurement should be blinded
39 and/or not the same person should assess every midpoint motor/sensory functional
40 measurement. However, PMDA instructed us to assess one patients' functional evaluation
41 by one evaluator for consistent assessment in respective patients. PMDA considers the
42 consistency of assessment in respective patients is more important.
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6 The precise explanation of abovementioned outcome measures is as followings (suppl.
7 Figures). ASIA motor score is determined by examining a function of 10 key muscles with
8 manual muscle testing (MMT) in the supine position¹⁷. The score ranges from 0 to 25 for
9 each extremity (MMT 0-5 in 5 muscles in each extremity), totaling 0 to 50 for the upper
10 limbs and 0 to 50 for the lower limbs, resulting in total of ASIA motor score ranges from 0
11 to 100. ASIA motor score shows the degree of motor impairment induced by SCI (suppl.
12 Figure 1)¹⁷. ASIA sensory scores is determined by sensory testing of a key point in each of
13 the 28 dermatomes (from C2 to S4-5) on the each sides of the body. Two aspects of
14 sensation are examined, light touch and pin prick, at all the key points. Light touch and pin
15 prick sensation is separately scored on a three-point scale, 0 = absent, 1= altered,
16 2 = normal or intact. As a result, ASIA sensory scores range from 0 to 112 (suppl. Figure 1)
17 in light touch and pin prick respectively¹⁷. AIS is used for gross grading of impairment:
18 A = Complete. No sensory or motor function is preserved in the sacral segments S4-S5.
19 B = Sensory incomplete. Sensory but not motor function is preserved below the
20 neurological level. C = Motor incomplete. Motor function is preserved below the
21 neurological level, and more than half of key muscle functions below the single
22 neurological level of injury have a muscle grade less than 3 (Grades 0–2). D = Motor
23 incomplete. Motor function is preserved below the neurological level, and at least half (half
24 or more) of key muscle functions below the neurological level have a muscle grade >3.
25 E = Normal¹⁷. If sensation and motor function as tested are graded as normal in all
26 segments, and the patient had prior deficits, then the AIS grade is E (suppl. Figure 1,
27 footnote)¹⁷. NLI refers to the most caudal segment of the cord with intact sensation and
28 antigravity muscle function strength, provided that there is normal (intact) sensory and
29 motor function rostrally (suppl. Figure 1, footnote)¹⁷. SCIM is disability scale developed
30 specifically for patients with spinal cord lesions in order to make the functional assessments
31 of patients with paraplegia or tetraplegia more sensitive to changes¹⁸. The SCIM includes
32 the following areas of function: self-care (subscore (0-20), respiration and sphincter
33 management (0-40) and mobility (0-40). Each area is scored according to its proportional
34 weight in these patients' general activity¹⁸. The final score ranges from 0 to 100 (suppl.
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Figure 2-4). EQ-5D essentially consists of 2 pages¹⁹ (suppl. Figure 5, 6): the EQ-5D descriptive system and the EQ visual analogue scale (EQ VAS). The descriptive system comprises five dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Each dimension has 5 levels: no problems, slight problems, moderate problems, severe problems and extreme problems. The patient is asked to indicate his/her health state by ticking the box next to the most appropriate statement in each of the five dimensions¹⁹. This decision results in a 1-digit number that expresses the level selected for that dimension. The digits for the five dimensions can be combined into a 5-digit number that describes the patient's health state and can be converted to efficacy score with calibration scale (ranges -0.111 to 1.000)¹⁹. The EQ VAS records the patient's self-rated health on a vertical visual analogue scale, where the endpoints are labelled 'The best health you can imagine' and 'The worst health you can imagine'. The VAS can be used as a quantitative measure of health outcome that reflect the patient's own judgement¹⁹.

Each group will include 44 patients (88 patients in total). Our protocol was approved by PMDA and this trial will be funded by the Center for Clinical Trials, Japan Medical Association.

Inclusion

Inclusion criteria are as follows. [1] Patients with cervical SCI (severity of AIS B/C) within 48 h of injury. [2] Patients reassessed for neurological status at 48 h after injury, and those whose palsy is AIS B/C will be enrolled. [3] Patients with neurological level of injury between C4 and C7. [4] Patients with age of 16 to 85 years. [5] Patients who agree to participate in the current trial and from whom informed consent was obtained orally and in writing. [6] Patients who can be followed up for 12 months after SCI.

Exclusion

Exclusion criteria are as follows. [1] Patients with neurological recovery to AIS D at neurological reassessment 48 h after SCI, because only AIS B/C patients will be included to

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

standardize the severity of paresis in order to stratify the patients at the initiation of drug administration. [2] Allergy to G-CSF. [3] Hematological malignancy, [4] within 6 months after invasive coronary intervention, [5] splenomegaly, or [6] pregnancy, [7] consciousness impairment, [8] neurological disorders that can affect neurological evaluation in the present trial, [9] fracture of extremities that can affect the neurological evaluation and [10] massive dose administration of MPSS. Exclusion criteria 2 - 6 are set for safety, criteria 1, 7 - 9 are set to maintain homogeneity of the patient population enrolled, criteria 7-9 are set for maintenance of accuracy of functional assessment, criteria 7 is set to obtain patients' own informed consent upon participation to the trial and criteria 10 is set to omit the possible interference of MPSS on outcome assessment.

Concealment

Patients will be administered drug or placebo and be evaluated in a double-blinded manner. An evaluator blinded to the treatment will take charge of patient evaluation including clinical findings and paresis, without laboratory data because G-CSF induces an apparent increase of white blood cell count that makes it easy to distinguish G-CSF and placebo treatment. Therefore, a non-blinded evaluator for laboratory data will be assigned to evaluate laboratory data alone. From a safety point-of view, the dose of G-CSF will be modulated according to excessive increase of white blood cell count. Therefore, a non-blinded evaluator will instruct the pharmacy to modulate the dose of G-CSF based on white blood cell count.

Sample Size Calculation

The target sample size for this randomized trial is 88. This number is based on the results of previous clinical trials¹⁶. The estimated group difference (\pm standard deviation) of change in ASIA motor scores from baseline to 3 months is 13.9 (\pm 21.9). A sample size of 44 patients in each group will provide 80% power to detect a difference of the change in ASIA motor scores between the G-CSF and the placebo treatments, using a mixed-effects models for repeated measures (MMRM) at a two-sided 5% level of significance. A

1
2
3
4
5 common correlation of 0.25 at each time point is assumed. A dropout rate of 10% is
6 allowed. Thus, the total sample size of 88 patients is required for the trial.
7
8
9

10 *Statistical analyses*

11 The analyses of the primary and secondary end points will be performed as
12 intention-to-treat analyses in a full analysis set, which includes all patients who: (1) took at
13 least one course of treatment during the study; (2) do not present any serious violation of
14 the study protocol; and (3) have data collected after commencement of treatment. For the
15 baseline characteristics, summary statistics will comprise frequencies and proportions for
16 categorical variables, and means and SDs for continuous variables. The patient
17 characteristics will be compared using a chi-square test for categorical variables, and a *t* test
18 or Wilcoxon rank sum test for continuous variables. Missing data including loss to
19 follow-up and missing measurement will be supplemented with MMRM.
20
21
22
23
24
25
26
27

28 For the primary analysis, aimed at comparing treatment effects, a change in ASIA motor
29 score from baseline to 3 months and its 95% confidence interval (CI) will be estimated
30 using the MMRM. To test for significant association of the primary endpoint, a mixed
31 effects model for repeated measures with an unstructured covariance matrix will be applied
32 to adjust for age (<65 years or ≥65 years) and AIS at 48 h after the injury (B or C).
33
34
35
36

37 For the secondary analysis, the change in ASIA motor score will be compared using a
38 Student *t* test and the 95% CI will be estimated. The same method will be applied to change
39 in sensory score, SCIM, and EQ-5D. A chi-squared test will be applied to the frequencies of
40 the responder in AIS and of the improvement in NLI. The frequency of AIS will be
41 summarized. The frequency of AEs will be compared using a Fisher exact test.
42
43
44

45 All comparisons are planned and all *p* values will be two sided. $p < 0.05$ will be
46 considered significant. All statistical analyses will be performed using SAS software
47 (version 9.4; SAS Institute, Cary, NC, USA). The statistical analysis plan will be developed
48 by the principal investigator and the biostatistician before completion of patient recruitment
49 and fixing of data.
50
51
52
53
54
55
56
57
58
59
60

Data Monitoring Committee

The data monitoring committee consists of three clinical trial specialists, including a biostatistician, who are independent from the current study. The committee will meet at least 2 times per year and all the data obtained by the current trial will be checked by the committee²⁰.

Adverse Events

As for safety evaluation, adverse events will be collected as follows. “Adverse events” refers to any untoward symptom or disease or signs of such (including clinical laboratory data abnormalities) in a clinical investigation subject after informed consent and does not necessarily have a causal relationship with the investigational product (G-CSF).

Increases in white blood counts will be considered an adverse event only when the count exceeds 50,000/ μ L from the perspective of a pharmacological effect of G-CSF, and any values below this will not be handled as an adverse event. Anaphylaxis and adult respiratory distress syndrome are the most representative G-CSF-related severe adverse events to be paid full attention.

All adverse events will code terminology used by the investigators according to the ICH International Medical Dictionary for Regulatory Activities Japanese version (MedDRA/J).

Ethics and Dissemination

Ethics

The study was approved by the Institutional Review Board (IRB) of each institutions involved to the present trial and will be conducted according to the principles of the World Medical Association (WMA) Declaration of Helsinki—Ethical Principles for Medical Research Involving Human Subjects with the amendments made in Seoul, South Korea, October 2008, with a Note of Clarification on Paragraph 29 added by the WMA General Assembly, Washington 2002; Note of Clarification on Paragraph 30 added by the WMA General Assembly, Tokyo 2004, and in accordance with the Japanese Medical Research Involving Human Subjects Act (WMO) and other guidelines, regulations and Acts.

Patient informed consent

The principal investigator will try to prepare the informed consent form and other explanatory materials in as simple language as possible in order to obtain informed consent from the patient and the patient's legal representative. In case that trial participants cannot sign the informed consent form due to upper extremity palsy caused by SCI, allograph by patients' representative will be allowed.

Public Disclosure and Publication Policy

Results of the clinical study will be submitted to the head of the respective clinical study site as a report after conclusion of the clinical study by the sponsor-investigator (includes study coordinating investigator). Even if the results are not favorable despite conducting the clinical study properly, the data will be published as a paper. Other sponsor-investigators (including the clinical study coordinating investigator), if they plan to publicize the data from this study in a specialized academic society conference or other external site, must first obtain permission from the other principal investigators and investigational product provider. In publicizing the results, the confidentiality of the subjects will be maintained and proofread in advance by the other sponsor-investigators (includes coordinating investigator) and investigational product provider.

Discussion

The current trial is a confirmative trial to elucidate the therapeutic efficacy of G-CSF for SCI. If the current trial can successfully show significant improvement of motor paralysis of SCI by G-CSF, we will move forward to drug approval application to the Ministry for Health and Labor, Japan. The entire protocol of the current trial was approved beforehand for the initiation of the current trial by the Japanese Pharmaceutical and Medical Device Agency (PMDA). The PMDA will also permit a drug approval application if significant efficacy of G-CSF for SCI is proven.

The current trial is an important milestone for SCI clinics and research to explore

1
2
3
4
5 G-CSF for SCI.
6
7

8
9 *Trial Status*

10 The present trial is now on-going.

11
12 *Trial Sites*

13
14 Nineteen major hospitals in Japan constituting the G-SPIRIT study group as follows:
15 Tohoku University Hospital, Miyagi; Niigata University, Niigata; Dokkyo University
16 Hospital, Tochigi; Tsukuba University Hospital, Ibaraki; Tsukuba Medical Center, Ibaraki;
17 Chiba University Hospital, Chiba; Funabashi Municipal Medical Center, Chiba; Kimitsu
18 Chuo Hospital, Chiba; Chiba Rosai Hospital, Chiba; Tokai University Hospital, Kanagawa;
19 Hamamatsu University Hospital, Shizuoka; Gifu University Hospital, Gifu; Chubu Rosai
20 Hospital, Aichi; Mie University Hospital, Mie; Kanazawa Medical Collage, Ishikawa;
21 Kobe Red Cross Hospital, Hyogo; Hiroshima University Hospital, Hiroshima; Yamaguchi
22 University Hospital, Yamaguchi; and Nagasaki Rosai Hospital, Nagasaki.
23
24
25
26
27
28
29
30

31 **Funding Statement**

32 This trial is supported by Center for Clinical trials, Japan Medical Association, Japan.
33 (<http://www.jmacct.med.or.jp/>, tel: 81-3-5319-3781)
34
35
36
37

38 **Competing Interests**

39 No authors have any competing interests to declare.
40
41
42

43 **Contributorship Statement**

44 Koda M, Hanaoka H, Sato T, Fujii Y, Hanawa M, Takahashi S, Furuya T, Ijima Y, Saito J,
45 Kitamura M, Ohtori S, Matsumoto Y, Abe T, Watanabe K, Hirano T, Ohashi M, Shoji H,
46 Mizouchi T, Takahashi I, Kawahara N, Kawaguchi M, Orita Y, Sasamoto T, Yoshioka M,
47 Fujii M, Yonezawa K, Soma D, Taneichi H, Takeuchi D, Inami S, Moridaira H, Ueda H,
48 Asano F, Shibao Y, Aita I, Takeuchi Y, Mimura M, Shimbo J, Someya Y, Ikenoue S,
49 Sameda H, Takase K, Ikeda Y, Nakajima F, Hashimoto M, Ozawa T, Hasue F, Fujiyoshi T,
50 Kamiya K, Watanabe M, Katoh H, Matsuyama Y, Yamamoto Y, Togawa D, Hasegawa T,
51
52
53
54
55
56
57

1
2
3
4
5 Kobayashi S, Yoshida G, Oe S, Banno T, Arima H, Akeda K, Kawamoto E, Imai H,
6 Sakakibara T, Sudo A, Ito Y, Kikuchi T, Osaki S, Tanaka N, Nakanishi K, Kamei I N,
7 Kotaka S, Baba H, Okudaira T, Konishi H, Yamaguchi T, Ito K, Katayama Y, Matsumoto
8 T, Matsumoto T, Idota M, Kanno H, Aizawa T, Hashimoto K, Eto T, Sugaya T, Matsuda
9 M, Fushimi K, Nozawa S, Iwai C, Taguchi T, Kanchiku T, Suzuki H, Nishida N, Funaba M
10 and Yamazaki M substantially contributed to the conception or design of the present trial
11 protocol, to the acquisition and analyses of data for the present manuscript, to drafting the
12 manuscript and revising the present manuscript critically for important intellectual content
13 and final approval of the version of the present manuscript to be published to agreement to
14 be accountable for all aspects of the present manuscript in ensuring that questions related to
15 the accuracy or integrity of any part of the present manuscript are appropriately
16 investigated and resolved, consequently fulfill the ICMJE criteria for authorship.
17
18
19
20
21
22
23
24
25
26
27

28 References

- 29 1. Oyinbo CA. Secondary injury mechanisms in traumatic spinal cord injury: a nugget
30 of multiply cascade. *Acta Neurobiol Exp* 2011;71:281-299.
- 31 2. Karsy M, Hawryluk G. Pharmacologic Management of Acute Spinal Cord Injury.
32 *Neurosurg Clin N Am* 2017;28:49-62. doi: 10.1016/j.nec.2016.07.002.
- 33 3. Bracken MB, Shepard MJ, Collins WF, et al. A randomized controlled trial of
34 methylprednisolone or naloxone in the treatment of acute spinal cord injury: results
35 of the second national acute spinal cord injury study. *N Engl J Med* 1990;322:
36 1405-1411.
- 37 4. Matsumoto T, Tamaki T, Kawakami M, et al. Early complications of high-dose
38 methyl-prednisolone sodium succinate treatment in the follow-up of acute cervical
39 spinal cord injury. *Spine* 2001;26: 426-430.
- 40 5. Hurlbert RJ, Hadley, Walters BC, et al. Pharmacological Therapy for Acute Spinal
41 cord Injury. *Neurosurgery* 2013;72: 93-105.
- 42 6. Nicola NA, Metcalf D, Matsumoto M, Johnson GR. Purification of a factor inducing
43 differentiation in murine myelomonocytic leukemia cells. Identification as
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

- granulocyte colony-stimulating factor. *J Biol Chem* 1983;258: 9017-9023.
7. Roberts AW: G-CSF: a key regulator of neutrophil production, but that's no all! *Growth Factors* 2005;23: 33-41.
 8. Kawada H, Takizawa S, Takanashi T, et al. Administration of hematopoietic cytokines in the subacute phase after cerebral infarction is effective for functional recovery facilitating proliferation of intrinsic neural stem/progenitor cells and transition of bone marrow-derived neuronal cells. *Circulation* 2006;113: 701-710.
 9. Schneider A, Kruger C, Steigleder T, et al. The hematopoietic factor G-CSF is a neuronal ligand that counteracts programmed cell death and drives neurogenesis. *J Clin Invest* 2005;115: 2083-2098.
 10. Shyu WC, Lin SZ, Lee CC, Liu DD, Li H. Granulocyte colony-stimulating factor for acute ischemic stroke: a randomized controlled trial. *CMAJ* 2006;174: 927-933.
 11. Koda M, Nishio Y, Kamada T, et al. Granulocyte colony-stimulating factor (G-CSF) mobilizes bone marrow-derived cells into injured spinal cord and promotes functional recovery after compression-induced spinal cord injury in mice. *Brain Res* 2007;1149: 223-231.
 12. Nishio Y, Koda M, Kamada T, et al. Granulocyte colony-stimulating factor (G-CSF) attenuates neuronal death and promotes functional recovery after spinal cord injury in mice. *J Neuropathol Exp Neurol* 2007;66: 724-731.
 13. Kadota R, Koda M, Kawabe J, et al. Granulocyte colony-stimulating factor (G-CSF) protects oligodendrocyte and promotes hindlimb functional recovery after spinal cord injury in rats. *PLoS One* 2012;7:e50391.
 14. Kawabe J, Koda M, Hashimoto M, et al. Granulocyte colony-stimulating factor (G-CSF) exerts neuroprotective effects via promoting angiogenesis after spinal cord injury in rats. *J Neurosurg Spine* 2011;15: 414-421.
 15. Takahashi H, Yamazaki M, Okawa A, et al. Neuroprotective therapy using granulocyte colony-stimulating factor for acute spinal cord injury: a phase I/IIa clinical trial. *Eur Spine J* 2012;21:2580-2587.
 16. Inada T, Takahashi H, Yamazaki M, et al. A multicenter prospective

1
2
3
4
5 non-randomized controlled clinical trial to prove neurotherapeutic effects of
6 granulocyte colony-stimulating factor (G-CSF) for acute spinal cord injury:
7
8 Analyses of follow-up cases after at least one year. *Spine* 2014;39:213-219.
9
10

11 12 13 Figure legends

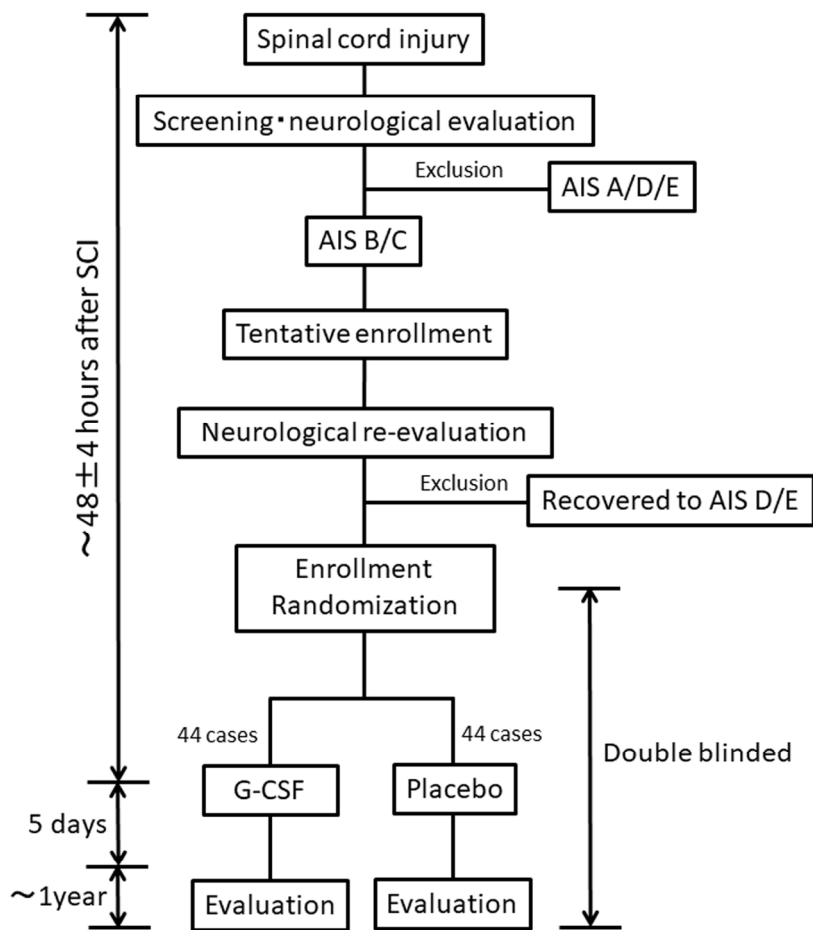
14 Figure: Schematic diagram showing trial timeline.

15
16 Cervical SCI with severity of AIS B/C within 48 hours after injury is recruited. Patients are
17 randomly assigned to G-CSF and placebo groups. The G-CSF group is administered G-CSF
18 in normal saline via intravenous infusion for 5 consecutive days. The placebo group is
19 similarly administered a placebo.
20
21
22

23
24
25 Suppl. Figure 1: ASIA score chart.
26
27

28
29 Suppl. Figure 2-4: Spinal cord independence measure chart (Japanese version) for spinal
30 cord injury-specific ADL evaluation.
31
32

33
34 Suppl. Figure 5, 6: Euro-QOL 5-dimension chart (Japanese version) for QOL evaluation.
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57



Schematic diagram showing trial timeline.

190x254mm (300 x 300 DPI)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY (ISNCSCI) **ASIA** **ISICOS**

Patient Name _____ Date/Time of Exam _____
 Examiner Name _____ Signature _____

RIGHT

MOTOR KEY MUSCLES

Elbow flexors C5
 Wrist extensors C6
 Elbow extensors C7
 Finger flexors C8
 Finger abductors (little finger) T1

UER
(Upper Extremity Right)

LER
(Lower Extremity Right)

Hip flexors L2
 Knee extensors L3
 Ankle dorsiflexors L4
 Long toe extensors L5
 Ankle plantar flexors S1

(VAC) Voluntary anal contraction (Yes/No)

RIGHT TOTALS
(MAXIMUM) (50) (56) (56)

Key Sensory Points

SENSORY KEY SENSORY POINTS
Light Touch (LTR) Pin Prick (PPR)

C2
C3
C4
C5
C6
C7
C8
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
L1
L2
L3
L4
L5
S1
S2
S3
S4-5

SENSORY KEY SENSORY POINTS
Light Touch (LTL) Pin Prick (PPL)

C2
C3
C4
C5
C6
C7
C8
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
L1
L2
L3
L4
L5
S1
S2
S3
S4-5

LEFT TOTALS
(MAXIMUM) (56) (56) (50)

LEFT

MOTOR KEY MUSCLES

Elbow flexors C5
 Wrist extensors C6
 Elbow extensors C7
 Finger flexors C8
 Finger abductors (little finger) T1

UEL
(Upper Extremity Left)

LEL
(Lower Extremity Left)

Hip flexors L2
 Knee extensors L3
 Ankle dorsiflexors L4
 Long toe extensors L5
 Ankle plantar flexors S1

(DAP) Deep anal pressure (Yes/No)

LEFT TOTALS
(MAXIMUM) (56) (56) (50)

MOTOR SUBSCORES
 UER + UEL = UEMS TOTAL
 LER + LEL = LEMS TOTAL
 LTR + LTL = LT TOTAL
 PPR + PPL = PP TOTAL

NEUROLOGICAL LEVELS
 1. SENSORY R L
 2. MOTOR R L
 3. NEUROLOGICAL LEVEL OF INJURY (NL)
 4. COMPLETE OR INCOMPLETE?
 5. ASIA IMPAIRMENT SCALE (AIS)

ZONE OF PARTIAL PRESERVATION
 (In complete injuries only)
 Most caudal level with any innervation

SENSORY R L
 MOTOR R L

This form may be copied freely but should not be altered without permission from the American Spinal Injury Association. REV 02/13

274x206mm (300 x 300 DPI)

セルフケア

- (1) 食事（切る、容器を開ける、飲み物を注ぐ、食べ物を口に運ぶ、飲み物の入ったコップをもつ）
0. 静脈栄養または胃瘻が必要である、あるいは経口摂取において全介助を要する。
 1. 食べたり飲んだりすること、または補助器具の装着に部分介助を要する。
 2. 食べることは自立、補助器具を必要とするか、または食べ物を切ったり注いだりすること、容器の開閉にのみ解介助を要する。
 3. 食べることも飲むことも自立、介助や補助器具を必要としない。
- (2) 入浴（頭と体を石鹸でこすって洗い、乾かす、蛇口の開け閉め） A—上半身、B—下半身
- A.
0. 全介助を要する。
 1. 部分介助を要する。
 2. 補助器具、または特定の環境（例えば、手すりや椅子）が整っていれば、自立して体を洗う。
 3. 自立して体を洗う。（通常、健常者なら用いることのない）補助器具や特定の環境設定は不要
- B.
0. 全介助を要する。
 1. 部分介助を要する。
 2. 補助器具、または特定の環境が整っていれば、自立して体を洗う。
 3. 自立して体を洗う、補助器具や特定の環境設定は不要
- (3) 更衣（衣服、靴、常用している装具の着脱） A—上半身、B—下半身
- A.
0. 全介助を要する。
 1. ボタン、ファスナー、ひものない衣服で部分介助を要する。
 2. ボタン、ファスナー、ひものない衣服であれば自立、補助器具と特定の環境設定、またはそのどちらかが必要。
 3. ボタン、ファスナー、ひものない衣服であれば自立、補助器具も特定の環境設定も不要、ボタン、ファスナー、ひもの扱いにだけ介助、補助器具、または特定の環境設定が必要。
 - 4.（衣類の種類を問わず）自立して着替える、補助器具も特定の環境設定も不要。
- B.
0. 全介助を要する。
 1. ボタン、ファスナー、ひものない衣服で部分介助を要する。
 2. ボタン、ファスナー、ひものない衣服であれば自立、補助器具と特定の環境設定、またはそのどちらかが必要。
 3. ボタン、ファスナー、ひものない衣服であれば自立、補助器具も特定の環境設定も不要、ボタン、ファスナー、ひもの扱いにだけ介助、補助器具、または特定の環境設定が必要。
 - 4.（衣類の種類を問わず）自立して着替える、補助器具も特定の環境設定も不要。
- (4) 整容（手洗い、洗顔、歯磨き、整髪、髭剃り、化粧）
0. 全介助を要する。
 1. 部分介助を要する。
 2. 補助器具があれば自立して整容動作をおこなう。
 3. 補助器具を用いずに自立して整容動作をおこなう。

小計 (0-20)

呼吸と排泄管理

- (5) 呼吸
0. 気管チューブと持続的補助換気または間欠的補助換気が必要。
 1. 気管チューブを装着して自己呼吸、酸素を必要としたり、咳嗽時または気管チューブの管理に多大な介助を必要とする。
 2. 気管チューブを装着して自己呼吸、咳嗽時または気管チューブの管理に少しか介助を必要としない。
 3. 気管チューブなしで自己呼吸、酸素、咳嗽時の多大な介助、マスク（例：終末呼吸陽圧 PEEP）、または間欠的補助換気 (BiPAP) を必要とする。
 4. 気管チューブなしで自己呼吸、介助または咳嗽刺激を少しか必要としない。
 5. 介助も器具もなしで自己呼吸。

190x254mm (300 x 300 DPI)

(6) 排尿管理

0. 留置カテーテル
3. 残尿量 > 100cc. 不定期導尿または介助による間欠的導尿.
6. 残尿量 > 100cc または間欠的の自己導尿. 集尿器¹をあてがう際の介助は必要.
9. 間欠的の自己導尿. 集尿器を使用する. 器具をあてがう際の介助は不要.
11. 間欠的の自己導尿. 導尿と導尿の間には失禁なし. 集尿器は使用しない.
13. 残尿量 < 100cc. 集尿器のみ必要. 集尿器の取扱いには介助不要.
15. 残尿量 < 100cc. 失禁なし. 集尿器を使用しない.

(7) 排便管理

0. 排便が不規則またはごく低頻度 (3日に1回未満).
5. 規則的ながら. (座薬を挿入するなど)に介助を要する. 失敗はまれ (月2回未満).
8. 規則的な排便で. 介助を要しない. 失敗はまれ (月2回未満).
10. 規則的な排便で. 介助を要しない. 失敗はなし.

(8) トイレの使用 (会陰部の清潔. 使用前後での衣服の扱い. ナプキンまたはおむつの使用)

0. 全介助を要する.
1. 部分介助を要する. 自分でお尻を拭けない.
2. 部分介助を要する. 自立してお尻を拭ける.
4. 自立してトイレを使用するも. 補助器具または特別な環境 (例: 手すり) が整っている必要あり.
5. 自立してトイレを使用. 補助器具も特別な環境が整っている必要もない.

小計 (0-40)

移動 (室内とトイレ)

(9) ベッド上での姿勢変換と褥瘡予防動作

0. ベッド上で上半身の向きを変えること. 下半身の向きを変えること. 起き上がること. および車椅子上で
のフッシュアップのすべての動作に介助が必要. 補助器具の要否は問わないが. 電動器具は用いない.
2. 介助なくできる動作が1つある.
4. 介助なくできる動作が2つまたは3つある.
6. ベッド上動作と除圧動作はすべて自立しておこなう.

(10) 移乗: ベッド-車椅子 (車いすのブレーキ操作. フットレストの跳ね上げ. アームレストの脱着. 乗り移り. 足の持ち上げ)

0. 全介助を要する.
1. 部分介助. 監視. および補助器具 (例: スライディングボード) のすべて. もしくは. そのいずれかが必要.
2. 自立 (または車椅子を必要としない).

(11) 移乗: 車椅子-トイレ. 浴槽 (トイレ用車椅子¹を使用している場合は. それへのからの乗り移り. 通常の車椅子を使用している場合は. 車椅子のブレーキ操作. フットレストの跳ね上げ. アームレストの脱着. 乗り移り. 足の持ち上げ)

0. 全介助を要する.
1. 部分介助. 監視. および補助器具 (例: 手すり) のすべて. もしくは. そのいずれかが必要.
2. 自立 (または車椅子を必要としない).

移動 (屋内と屋外. 平らな所で)

(12) 屋内の移動

0. 全介助を要する.
1. 電動車椅子を必要とするか. または手動車椅子を操作するのに部分介助を要する.
2. 手動車椅子で自立して移動する.
3. 歩行時に監視を必要とする (器具の要否は問わない).
4. 歩行器または松葉杖で歩行 (大振り・小振り歩行).
5. 松葉杖または T 字杖 2 本で歩行 (交互歩行).
6. T 字杖 1 本で歩行.
7. 下肢装具のみを必要とする.
8. 歩行補助具なしで歩行.

190x254mm (300 x 300 DPI)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

- (13) まとまった距離の移動 (10~100m)
 - 0. 全介助を要する。
 - 1. 電動車椅子を必要とするか、または手動車椅子を操作するのに部分介助を要する。
 - 2. 手動車椅子で自立して移動する。
 - 3. 歩行時に監視を必要とする(器具の要否は問わない)。
 - 4. 歩行器または松葉杖で歩行(大振り・小振り歩行)。
 - 5. 松葉杖または T 字杖 2 本で歩行(交互歩行)。
 - 6. T 字杖 1 本で歩行。
 - 7. 下肢装具のみを必要とする。
 - 8. 歩行補助具なしで歩行。

- (14) 屋外の移動 (100m 以上)
 - 0. 全介助を要する。
 - 1. 電動車椅子を使用するか、または手動車椅子を操作するのに部分介助を要する。
 - 2. 手動車椅子で自立して移動する。
 - 3. 歩行時に監視を必要とする(器具の要否は問わない)。
 - 4. 歩行器または松葉杖で歩行(大振り・小振り歩行)。
 - 5. 松葉杖または T 字杖 2 本で歩行(交互歩行)。
 - 6. T 字杖 1 本で歩行。
 - 7. 下肢装具のみを必要とする。
 - 8. 歩行補助具なしで歩行。

- (15) 階段昇降
 - 0. 階段の上り下り不能。
 - 1. 人に支えられるか、またはその監視下で少なくとも 3 段は上り下りできる。
 - 2. 手すりにつかまったり、松葉杖や T 字杖を用いて少なくとも 3 段は上り下りできる。
 - 3. 支えも監視もなく少なくとも 3 段は上り下りできる。

- (16) 移乗: 車椅子一車 (車に近づく、車椅子のブレーキ操作、アームレストおよびフットレストの取り外し、車へのからの乗り移り、車椅子の積み降ろし)
 - 0. 全介助を要する。
 - 1. 部分介助、監視、および補助器具のすべて、もしくはいずれかを必要とする。
 - 2. 自立して移乗する。補助器具を必要としない(または車椅子を必要としない)。

- (17) 移乗: 床一車椅子
 - 0. 介助を要する。
 - 1. 補助器具の有無にかかわらず、自立して移乗する(または車椅子を必要としない)。

小計(0-40)

SCIM 合計スコア(0-100)

訳者注

- 1. 夜間のみ BPAP を使用している場合も 0 点とする
 - 2. 原書では external drainage instrument、体外からあててるのみが在宅医療器具集積器のこと指す。例えば、コンドーム型集積器、しびんなどが含まれる。尿導管や膀胱に挿入するカテーテルは含まれない
 - 3. ベッド横やひもなどを使ってもよい
 - 4. 原書では toilet wheelchair、便器や浴槽に移乗することなく、乗車したまま洋式便器が使用でき、シャワー浴にも使える車椅子のこと。介助型と自立型がある。わが国ではトイレ兼用シャワーキヤリー(介助型)が用いられることがある
- SCIM (Version 3.0) 日本語版 朝川博之・黒川真希子・出田良輔・星宇明光訳
 [Translated by permission from Dr. Amiram Catz, Loewenstein Rehabilitation Hospital, Raanana, Israel]
 [Reprinted by permission from Macmillan Publishers Ltd. Spinal cord 40: 396-407, copyright 2002]

190x254mm (300 x 300 DPI)

以下のそれぞれの項目の一つの四角に（このように☐）印をつけて、あなた自身の今日の健康状態を最も良く表している記述を示して下さい。

移動の程度

歩き回るのに問題はない

歩き回るのにいくらか問題がある

ベッド（床）に寝たきりである

身の回りの管理

身の回りの管理に問題はない

洗面や着替えを自分でするのにいくらか問題がある

洗面や着替えを自分でできない

ふだんの活動（例：仕事、勉強、家事、家族・余暇活動）

ふだんの活動を行うのに問題はない

ふだんの活動を行うのにいくらか問題がある

ふだんの活動を行うことができない

痛み／不快感

痛みや不快感はない

中程度の痛みや不快感がある

ひどい痛みや不快感がある

不安／ふさぎ込み

不安でもふさぎ込んでもいない

中程度に不安あるいはふさぎ込んでいる

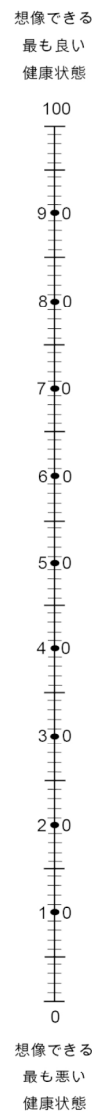
ひどく不安あるいはふさぎ込んでいる

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

健康状態がどのくらい良いか悪いかを表わしてもらうために、(温度計に似たような) 目盛を描きました。目盛には、あなたの想像できる最も良い状態として 100、あなたの想像できる最も悪い状態として 0 が付けられています。

あなたの今日の健康状態がどのくらい良いか悪いかを、あなたの考えでこの目盛上に示して下さい。下の「あなたの今日の健康状態」と書かれた四角から、あなたの現在の健康状態のよし悪しを示す目盛上の点まで、線を引いて下さい。

**あなたの
今日の
健康状態**





SPIRIT 2013 Checklist: Recommended items to address in a clinical trial protocol and related documents*

Section/item	Item No	Description	Addressed on page number
Administrative information			
Title	1	Descriptive title identifying the study design, population, interventions, and, if applicable, trial acronym	<u>1</u>
Trial registration	2a	Trial identifier and registry name. If not yet registered, name of intended registry	<u>3</u>
	2b	All items from the World Health Organization Trial Registration Data Set	<u>3</u>
Protocol version	3	Date and version identifier	<u>3</u>
Funding	4	Sources and types of financial, material, and other support	<u>15</u>
Roles and responsibilities	5a	Names, affiliations, and roles of protocol contributors	<u>1-2</u>
	5b	Name and contact information for the trial sponsor	<u>15</u>
	5c	Role of study sponsor and funders, if any, in study design; collection, management, analysis, and interpretation of data; writing of the report; and the decision to submit the report for publication, including whether they will have ultimate authority over any of these activities	<u>15</u>
	5d	Composition, roles, and responsibilities of the coordinating centre, steering committee, endpoint adjudication committee, data management team, and other individuals or groups overseeing the trial, if applicable (see Item 21a for data monitoring committee)	<u>13</u>

Introduction

Background and rationale	6a	Description of research question and justification for undertaking the trial, including summary of relevant studies (published and unpublished) examining benefits and harms for each intervention	<u>4-6</u>
	6b	Explanation for choice of comparators	<u>6</u>
Objectives	7	Specific objectives or hypotheses	<u>6</u>
Trial design	8	Description of trial design including type of trial (eg, parallel group, crossover, factorial, single group), allocation ratio, and framework (eg, superiority, equivalence, noninferiority, exploratory)	<u>6-8</u>

Methods: Participants, interventions, and outcomes

Study setting	9	Description of study settings (eg, community clinic, academic hospital) and list of countries where data will be collected. Reference to where list of study sites can be obtained	<u>15</u>
Eligibility criteria	10	Inclusion and exclusion criteria for participants. If applicable, eligibility criteria for study centres and individuals who will perform the interventions (eg, surgeons, psychotherapists)	<u>11</u>
Interventions	11a	Interventions for each group with sufficient detail to allow replication, including how and when they will be administered	<u>6-8</u>
	11b	Criteria for discontinuing or modifying allocated interventions for a given trial participant (eg, drug dose change in response to harms, participant request, or improving/worsening disease)	<u>13</u>
	11c	Strategies to improve adherence to intervention protocols, and any procedures for monitoring adherence (eg, drug tablet return, laboratory tests)	<u>7</u>
	11d	Relevant concomitant care and interventions that are permitted or prohibited during the trial	<u>11</u>
Outcomes	12	Primary, secondary, and other outcomes, including the specific measurement variable (eg, systolic blood pressure), analysis metric (eg, change from baseline, final value, time to event), method of aggregation (eg, median, proportion), and time point for each outcome. Explanation of the clinical relevance of chosen efficacy and harm outcomes is strongly recommended	<u>8-10</u>
Participant timeline	13	Time schedule of enrolment, interventions (including any run-ins and washouts), assessments, and visits for participants. A schematic diagram is highly recommended (see Figure)	<u>Figure</u>

1
2
3 Sample size 14 Estimated number of participants needed to achieve study objectives and how it was determined, including 11-12
4 clinical and statistical assumptions supporting any sample size calculations

5
6 Recruitment 15 Strategies for achieving adequate participant enrolment to reach target sample size 15
7

8 **Methods: Assignment of interventions (for controlled trials)**
9

10 Allocation:

11
12 Sequence generation 16a Method of generating the allocation sequence (eg, computer-generated random numbers), and list of any 6
13 factors for stratification. To reduce predictability of a random sequence, details of any planned restriction
14 (eg, blocking) should be provided in a separate document that is unavailable to those who enrol participants
15 or assign interventions
16

17 Allocation concealment mechanism 16b Mechanism of implementing the allocation sequence (eg, central telephone; sequentially numbered, 6
18 opaque, sealed envelopes), describing any steps to conceal the sequence until interventions are assigned
19
20

21 Implementation 16c Who will generate the allocation sequence, who will enrol participants, and who will assign participants to 6-7
22 interventions
23

24 Blinding (masking) 17a Who will be blinded after assignment to interventions (eg, trial participants, care providers, outcome 7, 11
25 assessors, data analysts), and how
26

27 17b If blinded, circumstances under which unblinding is permissible, and procedure for revealing a participant's 11
28 allocated intervention during the trial
29
30

31 **Methods: Data collection, management, and analysis**
32

33 Data collection methods 18a Plans for assessment and collection of outcome, baseline, and other trial data, including any related 8-10
34 processes to promote data quality (eg, duplicate measurements, training of assessors) and a description of
35 study instruments (eg, questionnaires, laboratory tests) along with their reliability and validity, if known.
36 Reference to where data collection forms can be found, if not in the protocol
37

38 18b Plans to promote participant retention and complete follow-up, including list of any outcome data to be 12-13
39 collected for participants who discontinue or deviate from intervention protocols
40
41
42
43
44

1				
2				
3	Data management	19	Plans for data entry, coding, security, and storage, including any related processes to promote data quality (eg, double data entry; range checks for data values). Reference to where details of data management procedures can be found, if not in the protocol	<u>13</u>
4				
5				
6				
7	Statistical methods	20a	Statistical methods for analysing primary and secondary outcomes. Reference to where other details of the statistical analysis plan can be found, if not in the protocol	<u>12-13</u>
8				
9				
10		20b	Methods for any additional analyses (eg, subgroup and adjusted analyses)	<u>12-13</u>
11				
12		20c	Definition of analysis population relating to protocol non-adherence (eg, as randomised analysis), and any statistical methods to handle missing data (eg, multiple imputation)	<u>12-13</u>
13				
14				
15	Methods: Monitoring			
16				
17	Data monitoring	21a	Composition of data monitoring committee (DMC); summary of its role and reporting structure; statement of whether it is independent from the sponsor and competing interests; and reference to where further details about its charter can be found, if not in the protocol. Alternatively, an explanation of why a DMC is not needed	<u>13</u>
18				
19				
20				
21				
22		21b	Description of any interim analyses and stopping guidelines, including who will have access to these interim results and make the final decision to terminate the trial	<u>N/A</u>
23				
24				
25	Harms	22	Plans for collecting, assessing, reporting, and managing solicited and spontaneously reported adverse events and other unintended effects of trial interventions or trial conduct	<u>13</u>
26				
27				
28	Auditing	23	Frequency and procedures for auditing trial conduct, if any, and whether the process will be independent from investigators and the sponsor	<u>Not in the protocol</u>
29				
30				
31				
32	Ethics and dissemination			
33				
34	Research ethics approval	24	Plans for seeking research ethics committee/institutional review board (REC/IRB) approval	<u>13-14</u>
35				
36				
37	Protocol amendments	25	Plans for communicating important protocol modifications (eg, changes to eligibility criteria, outcomes, analyses) to relevant parties (eg, investigators, REC/IRBs, trial participants, trial registries, journals, regulators)	<u>Patient consent form</u>
38				
39				
40				
41				
42				
43				
44				
45				
46				
47				

1				
2				
3	Consent or assent	26a	Who will obtain informed consent or assent from potential trial participants or authorised surrogates, and how (see Item 32)	<u>13</u>
4				
5				
6		26b	Additional consent provisions for collection and use of participant data and biological specimens in ancillary studies, if applicable	<u>N/A</u>
7				
8	Confidentiality	27	How personal information about potential and enrolled participants will be collected, shared, and maintained in order to protect confidentiality before, during, and after the trial	<u>14</u>
9				
10				
11	Declaration of interests	28	Financial and other competing interests for principal investigators for the overall trial and each study site	<u>15</u>
12				
13				
14	Access to data	29	Statement of who will have access to the final trial dataset, and disclosure of contractual agreements that limit such access for investigators	<u>14</u>
15				
16				
17	Ancillary and post-trial care	30	Provisions, if any, for ancillary and post-trial care, and for compensation to those who suffer harm from trial participation	<u>Patient consent form</u>
18				
19	Dissemination policy	31a	Plans for investigators and sponsor to communicate trial results to participants, healthcare professionals, the public, and other relevant groups (eg, via publication, reporting in results databases, or other data sharing arrangements), including any publication restrictions	<u>14</u>
20				
21				
22				
23				
24				
25		31b	Authorship eligibility guidelines and any intended use of professional writers	<u>14-15</u>
26				
27		31c	Plans, if any, for granting public access to the full protocol, participant-level dataset, and statistical code	<u>N/A</u>
28				
29	Appendices			
30				
31	Informed consent materials	32	Model consent form and other related documentation given to participants and authorised surrogates	<u>Patient consent form</u>
32				
33				
34	Biological specimens	33	Plans for collection, laboratory evaluation, and storage of biological specimens for genetic or molecular analysis in the current trial and for future use in ancillary studies, if applicable	<u>N/A</u>
35				
36				

37 *It is strongly recommended that this checklist be read in conjunction with the SPIRIT 2013 Explanation & Elaboration for important clarification on the items.
 38 Amendments to the protocol should be tracked and dated. The SPIRIT checklist is copyrighted by the SPIRIT Group under the Creative Commons
 39 "[Attribution-NonCommercial-NoDerivs 3.0 Unported](https://creativecommons.org/licenses/by-nc-nd/3.0/)" license.
 40