corpse is during the first 24 hours after death. By day 5, the amount of infectious virus has decreased by 96.48%. If proper biosafety precautions and personal protective equipment are used to handle the corpse during autopsy or preparation for burial or cremation, we believe that the burial or cremation process is unlikely to spread disease.

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Guillain-Barré Syndrome Associated with COVID-19 Vaccination
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We conducted a multi-institutional study in Taiwan and a systematic review of the literature for reports of Guillain-Barré syndrome after coronavirus disease vaccination. This condition, mostly the classic form and the acute inflammatory demyelinating polyneuropathy subtype, has been reported in 39 cases and has occurred within 2 weeks of vaccine administration.

Guillain-Barré syndrome (GBS), an immune-mediated polyradiculoneuropathy with a ≈5% mortality rate, has an incidence worldwide of 0.81–1.91 cases/100,000 person-years (1). GBS has been

1These authors contributed equally to this article.
reported to be associated with coronavirus disease (COVID-19) vaccination, but a comprehensive summary regarding this rare adverse event is still lacking. To determine clinical features of GBS associated with COVID-19 vaccination, we conducted hospital-based investigations in Taiwan along with a systematic review of published case reports.

We analyzed electronic medical records data from Taiwan’s largest multi-institutional healthcare system, including 9 branches of Chang Gung Memorial Hospital (2), where healthcare workers received first-priority COVID-19 ChAdOx1-NCoV2 vaccine (Oxford/AstraZeneca, https://www.astrazeneca.com) starting March 22, 2021. We included healthcare workers vaccinated during March 22–May 31 and followed them for 30 days after vaccination. We identified GBS cases on the basis of code G610 from the International Classification of Disease, 10th Revision, Clinical Modification, or spontaneous adverse drug reaction reporting systems within the hospitals. Two authors (C.H.W. and S.C.L.) confirmed diagnosis and classification of GBS cases through chart reviews (3,4). This study was approved by the Institutional Review Board of Chang Gung Medical Foundation (approval no. 202101087B0).

To summarize clinical features of published cases from literature, we searched PubMed and Embase for reports posted through August 17, 2021, using relevant key terms such as “COVID-19,” “Guillain-Barré syndrome,” and “vaccine” with suitable MeSH terms. Two independent reviewers (S.C.S., C.H.W.) performed the study selection and data extraction; a third-reviewer (S.C.L.) settled any differences between them. We excluded cases with coexisting COVID-19 or preexisting GBS. We included only publications with reports of clinical features related
neuropathy (3/33). For GBS management, 33 cases were identified: axonal neuropathy (4/33) and acute motor axonal neuropathy (23/33), followed by acute motor and sensory neuropathy (11/33). Most reported case-patients had a diagnosis of acute inflammatory demyelinating polyneuropathy; most reported case-patients had a diagnosis of acute inflammatory demyelinating polyneuropathy (2/33) and followed by acute motor axonal neuropathy (4/33) and acute motor axonal neuropathy (3/33). For GBS management, 33 case-patients received intravenous immunoglobulin and 2 received plasmapheresis. One case-patient died; 9 case-patients required mechanical ventilation during hospitalization. The scores on the GBS disability scale (5) were only available for 30 cases; 12 scored >4 (i.e., indicating bedridden or chair-bound status) during follow-up or after discharge.

Similar to previous reviews on GBS associated with COVID-19, we found that both COVID-19 and COVID-19 vaccination mostly cause the classic form of GBS (under the clinical diagnosis classification) and the acute inflammatory demyelinating polyneuropathy subtype (based on electrodiagnostic features) within 2 weeks of infection or vaccination (6–8). However, the bilateral facial palsy with paresthesia variant and initial onset symptoms of facial diplegia were more frequently found in GBS case-patients after COVID-19 vaccination.

Case series and reports can indicate safety issues and outline clinical features of diseases, but they cannot establish robust causal relationships between COVID-19 vaccination and GBS. Despite the benefits (e.g., increase in the number of persons not susceptible to infection and decrease in severe outcomes after infection) of COVID-19 vaccination far outweighing the potentially severe adverse events after infection (9), our findings highlight the need for vigilance in patients with neurologic symptoms after COVID-19 vaccination and for postvaccination surveillance programs to assess causality of GBS.

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Dr. Shao is a clinical pharmacist at Keelung Chang Gung Memorial Hospital. His research interests include the use of systematic review and meta-analysis to summarize current best evidence on clinical topics, specifically in regard to complications in COVID-19 patients.

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Limited Protection of Inactivated SARS-CoV-2 Vaccine against Wild-Type Strain and Variants of Concern

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Circulation of novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) variants capable of evading vaccine-derived protection is challenging the efficacy of coronavirus disease (COVID-19) vaccines (1). The inactivated SARS-CoV-2 vaccine CoroNaVac (Sinovac Biotech, http://www.sinovac.com), 1 of 2 COVID-19 vaccines licensed in Thailand, has been widely administered to health care workers. Clinical studies show CoronaVac efficacy against symptomatic COVID-19 ranging from 51% (Brazil) to 65.9% (Chile) and 100% against severe illness and illness requiring hospitalization (2,3). However, data on CoronaVac efficacy against variants of concern are very limited. Our study was approved by the Research Ethics Review Committee, Faculty of Medicine, Chulalongkorn University (Bangkok, Thailand) and recorded in the Thai Clinical Trial Registry (TCTR20210325003). Investigators adhered to U.S. Department of Defense AR 70–25 policies for protection of human subjects.

For this study, we enrolled 207 health care workers in Thailand who were fully vaccinated with 2 doses of CoronaVac (0.5 mL/dose, 2–4 wk between doses); all had received their first dose during February 22–March 12, 2021. Median age was 39 (interquartile range 30–51) years of age; 67 (49.6%) were men. Among study participants, 58 (28%) provided blood samples only at baseline (when the first dose was administered), 93 (44.0%) both at baseline and 2–3 weeks after the second dose, and 56 (27.0%) at baseline and at 2–3 weeks and 10–12 weeks after the second dose. Using an in vitro system (Appendix, https://wwwnc.cdc.gov/EID/article/27/12/21-1772-App1.pdf), we evaluated the ability of the serum of CoronaVac...
### Guillain-Barré Syndrome Associated with COVID-19 Vaccination

#### Appendix

#### Appendix Table. Clinical features of GBS associated with COVID-19 vaccination*

| Author name (country) | Author name (country) | GBS rate | Age, y | Sex | Vaccine | Vaccination to symptom onset, d | Initial symptoms (dysautonomia) | Albuninocytologic dissociation (CSF protein, mg/dl) | Clinical classification | Electrodiagnosis | Brighton criteria† | Antiganglioside antibody | Treatment (drug dose) | Mechanical ventilation | Outcome (GBS disability scale‡) |
|----------------------|----------------------|----------|--------|-----|---------|---------------------------------|---------------------------------|---------------------------------|----------------------|----------------|----------------|-------------------|------------------|---------------------|------------------------|
| Presented case (Taiwan) | Theuriet J, et al (France) (1) | 1/18,801 (ChAdOx1 nCoV-19) | 41 | M | ChAdOx1 (1st dose) | 7 | Paresthesia, facial diplegia (No) | Yes (159.8) | Bilateral facial palsy with paresthesia | Equivocal | NA | NA | IVIG (0.4g/kg/day for 5 days) | No | Survived (1) |
| | Hasan T, et al (UK) (2) | NA | 72 | M | ChAdOx1 (1st dose) | 21 | Myalgia, paresthesia, dysarthria, ascending paralysis, facial diplegia (No) | Yes (62.0) | Classic GBS AIDP 1 | Anti-GM3 IgM positive | IVIG (0.4g/kg/day for 5 days) | No | Survived (NA) |
| | Allen CM, et al (UK) (3) | 4/712,050 (ChAdOx1 nCoV-19) | 54 | M | ChAdOx1 (1st dose) | 12 | Paresthesia, facial diplegia (No) | Yes (162.6) | Bilateral facial palsy with paresthesia | Equivocal | NA | Negative | Prednisolone (60mg for 5 days) | No | Survived (NA) |
| | | 20 | M | ChAdOx1 (1st dose) | 22 | Paresthesia, facial diplegia (No) | Yes (123.2) | Bilateral facial palsy with paresthesia | Equivocal | NA | Negative | Prednisolone (60mg for 5 days) | No | Survived (NA) |
| | | 57 | M | ChAdOx1 (1st dose) | 15 | Back pain, paresthesia, dysarthria, facial diplegia (No) | Yes (247.1) | Bilateral facial palsy with paresthesia | Not done | NA | Negative | IVIG | No | Survived (NA) |
| Author name (country) | GBS rate | Age, y | Sex | Vaccine | Vaccination to symptom onset, d | Initial symptoms | Albuminocytologic dissociation (CSF protein, mg/dl) | Clinical classification | Electro-diagnosis | Brighton criteria† | Antiganglioside antibody | Treatment (drug dose) | Mechanical ventilation | Outcome (GBS disability scale‡) |
|----------------------|----------|-------|-----|---------|-------------------------------|-----------------|---------------------------------|------------------------|----------------|----------------|-------------------|-------------------------|---------------------|--------------------------|
| Maramattom BV, et al (India) (4) | 7/1,200,000 (ChAdOx1 nCoV-19) | 43 F | ChAdOx1 (1st dose) | 10 | Back pain, quadriaparesis, facial diplegia (No) | Yes (85.0) | Classic GBS | AIDP 1 | NA | Negative | IVIG | No | Survived (0) |
| 67 F | ChAdOx1 (1st dose) | 14 | Paresthesia, quadriaparesis, facial diplegia (No) | Yes (345.0) | Classic GBS | AMSAN 1 | Negative | IVIG (NA) | Plasmapheresis | Yes | Survived (4) |
| 53 F | ChAdOx1 (1st dose) | 12 | Paresthesia, quadriaparesis, facial diplegia (No) | Yes (120.0) | Classic GBS | AIDP 1 | Negative | IVIG (NA) | Yes | Survived (4) |
| 68 F | ChAdOx1 (1st dose) | 14 | Paresthesia, quadriaparesis, dysphagia, facial diplegia (No) | Yes (75.0) | Classic GBS | AIDP 2 | Negative | IVIG (NA) | Yes | Survived (4) |
| 70 M | ChAdOx1 (1st dose) | 11 | Paresthesia, quadriaparesis, facial diplegia (No) | NA | Classic GBS | AIDP 2 | NA | IVIG (NA) | Yes | Survived (4) |
| 69 F | ChAdOx1 (1st dose) | 12 | Paresthesia, quadriaparesis, facial diplegia (No) | NA | Classic GBS | AIDP 2 | NA | IVIG (NA) | Plasmapheresis | No | Survived (4) |
| 69 F | ChAdOx1 (1st dose) | 13 | Paresthesia, quadriaparesis, facial diplegia (No) | Yes (83.0) | Classic GBS | AIDP 1 | NA | IVIG (NA) | Yes | Survived (5) |
| Ogbebor O, et al (USA) (5) | NA | 86 F | BNT162b2 (1st dose) | 1 | Paraparesis (No) | Yes (162.0) | Paraparetic | Not done | 2 | NA | IVIG (NA) | No | Survived (3) |
| Patel SU, et al (UK) (6) | NA | 37 M | ChAdOx1 (1st dose) | 14 | Back pain, paresthesia, ascending paralysis (No) | Yes (177.0) | Classic GBS | Not done | 2 | NA | IVIG (2g/kg/day for 5 days) | No | Survived (NA) |
| Márquez Loza AM, et al (USA) (7) | NA | 60 F | Ad26.COV2.S (1st dose) | 10 | Back pain, paresthesia, facial diplegia (No) | Yes (140.0) | GBS / MFS overlap variants | AIDP 1 | Negative | IVIG (2g/kg/day for 2 days) | No | Survived (NA) |
| Author name (country) | GBS rate | Age, y | Sex | Vaccine | Vaccination to symptom onset, d | Initial symptoms (dysautonomia) | Albuminocytologic dissociation (CSF protein, mg/dl) | Clinical classification | Electro-diagnosis | Brighton criteria† | Antiganglioside antibody | Treatment (drug dose) | Mechanical ventilation | Outcome (GBS disability scale‡) |
|----------------------|---------|-------|-----|---------|-------------------------------|-------------------------------|---------------------------------|------------------------|-----------------|------------------|-----------------------------|--------------------------|------------------------|--------------------------|
| Waheed S, et al (USA) (8) | NA 82 F | BNT162b2 (1st dose) | 14 | Myalgia, paresthesia, paraparesis BP fluctuation | Yes (88.0) | Paraparetic | Not done | 2 | NA | IVIG (NA) | No | Survived (NA) |
| Razok A, et al (Qatar) (9) | NA 73 M | BNT162b2 (2nd dose) | 16 | Paraparesis (No) | Yes (80.0) | Paraparetic | AIDP | 1 | NA | IVIG (0.4g/kg/day for 5 days) | No | Survived (0) |
| Nasuelli NA, et al (Italy) (10) | NA 59 M | ChAdOx1 (1st dose) | 10 | Paresthesia, facial diplegia (No) | Yes (140) | Bilateral facial palsy with paresthesia | AIDP | NA | Negative | IVIG (0.4g/kg/day for 5 days) | No | Survived (NA) |
| Bonifacio GB, et al (UK) (11) | NA 66 M | ChAdOx1 (1st dose) | 7 | Back pain, paresthesia, facial diplegia (No) | Yes (199) | Bilateral facial palsy with paresthesia | AIDP | NA | Negative | IVIG (NA) | No | Survived (1) |
| | 43 M | ChAdOx1 (1st dose) | 11 | Myalgia, paresthesia, facial diplegia Urinary retention | Yes (281) | Bilateral facial palsy with paresthesia | AIDP | NA | Negative | IVIG (NA) | No | Survived (2) |
| | 51 M | ChAdOx1 (1st dose) | 7 | Myalgia, paresthesia, facial diplegia (No) | Yes (514) | Bilateral facial palsy with paresthesia | AIDP | NA | Anti-GM3 positive, anti-GM4 borderline | No treatment | No | Survived (2) |
| | 71 F | ChAdOx1 (1st dose) | 12 | Back pain, Paresthesia, facial diplegia (No) | Yes (96) | Bilateral facial palsy with paresthesia | AIDP | NA | Negative | No treatment | No | Survived (2) |
| | 53 M | ChAdOx1 (1st dose) | 8 | Paresthesia, facial diplegia (No) | Yes (122) | Bilateral facial palsy with paresthesia | Not done | NA | Negative | No treatment | No | Survived (1) |
| | | ChAdOx1 (1st dose) | 10 | Back pain, facial diplegia, paresthesia, quadriaparesis (No) | Yes (126.4) | Classic GBS | AIDP | 1 | Negative | IVIG (2g/kg/day for 5 days) | No | Survived (1) |
| | | ChAdOx1 (1st dose) | 11 | Quadriaparesis, paresthesia, facial diplegia (No) | Yes (149) | Classic GBS | AMSAN | 1 | NA | IVIG (2g/kg/day for 5 days) | No | Survived (3) |
| Author name (country) | GBS rate | Age, y | Sex | Vaccine | Initial symptoms (dysautonomia) | Vaccination to symptom onset, d | Initial symptoms | Albuminocytologic dissociation (CSF protein, mg/dl) | Clinical classification | Electrodiagnosis | Brighton criteria† | Antiganglioside antibody | Treatment (drug dose) | Mechanical ventilation | Outcome (GBS disability scale‡) |
|----------------------|---------|--------|-----|---------|-------------------------------|-----------------------------|----------------|---------------------------------|----------------------|----------------|----------------|-----------------------------|---------------------|-------------------------|-------------------------------|
| Garcia-Grimshaw M, et al (Mexico) (14) | 7/3,890,250 (BNT162b2) | 33 M | BNT162b2 (1st dose) | 28 | Facial diplegia (No) | Yes (67.1) | Bilateral facial palsy with paresthesia | AIDP | NA | NA | IVIG (NA) | No | Survived (1) |
| Trimboli M, et al (Italy) (15) | NA | 53 F | BNT162b2 (1st dose) | 6 | Quadripareisia (No) | No (15) | Classic GBS | AMAN | 2 | NA | IVIG (NA) | Yes | Survived (5) |
| Tutar NK, et al (Turkey) (16) | NA | 76 M | CoronaVac (2nd dose) | 5 | Myalgia, ascending paralysis (No) | No (NA) | Classic GBS | AMSAN | 2 | Negative | IVIG (2g/kg/day for 5 days) | No | Survived (2) |

66 M ChAdOx1 (1st dose) | 12 | Ascending paralysis, paresthesia, Urinary retention, BP fluctuation | Yes (84) | Classic GBS | AIDP | 1 | NA | IVIG (2g/kg/day for 5 days), Methylprednisolone (1000 mg for 3 days) | No | Survived (3) |

54 F ChAdOx1 (1st dose) | 13 | Quadripareisia, paresthesia, dysphagia (No) | NA | Classic GBS | AIDP | 2 | Negative | IVIG (2g/kg/day for 5 days), Methylprednisolone (1000 mg for 3 days) | No | Survived (2) |

25 M BNT162b2 (1st dose) | 12 | Paresthesia, quadripareisia (No) | Yes (64) | Classic GBS | AIDP | 1 | NA | IVIG (NA) | No | Survived (3) |

53 F BNT162b2 (1st dose) | 6 | Quadripareisia (No) | No (15) | Classic GBS | AMAN | 2 | NA | IVIG (NA) | Yes | Survived (5) |

72 M BNT162b2 (1st dose) | 4 | Quadripareisia (No) | NA | Classic GBS | AMAN | 2 | NA | IVIG (NA) | No | Survived (4) |

31 M BNT162b2 (1st dose) | 11 | Quadripareisia (No) | NA | Classic GBS | AIDP | 2 | NA | IVIG (NA) | No | Survived (3) |

67 F BNT162b2 (1st dose) | 4 | Quadripareisia (No) | No (30) | Classic GBS | AMAN | 2 | NA | IVIG (NA) | Yes | Expired (6) |

81 F BNT162b2 (1st dose) | 3 | Quadripareisia (No) | Yes (414) | Classic GBS | AIDP | 1 | NA | IVIG (NA) | No | Survived (4) |

Trimboli M, et al (Italy) (15) | NA | 25 F | BNT162b2 (2nd dose) | 5 | Paraparesis, paresthesia (No) | No (NA) | Paraparetic | AIDP | 2 | NA | IVIG (0.4g/kg/day for 5 days) | No | Survived (2) |

Tutar NK, et al (Turkey) (16) | NA | 76 M | CoronaVac (2nd dose) | 5 | Myalgia, ascending paralysis (No) | No (NA) | Classic GBS | AMSAN | 2 | Negative | IVIG (2g/kg/day for 5 days) | No | Survived (2) |
| Author name | GBS rate | Age, y | Sex | Vaccine | Vaccination to symptom onset, d | Initial symptoms (dysautonomia) | Albuminocytologic dissociation (CSF protein, mg/dl) | Clinical classification | Electro-diagnosis | Brighton criteria† | Antiganglioside antibody | Treatment (drug dose) | Mechanical ventilation | Outcome (GBS disability scale‡) |
|------------|---------|-------|-----|---------|-----------------|-------------------|-----------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|--------------------------|
| Scendoni R, et al (Italy) (17) | NA | 82 | F | BNT162b2 (2nd dose) | 15 | Ascending paralysis, paresthesia (No) | Yes (570) | Classic GBS | AMSAN | 1 | Anti-sulfatide IgG and IgM positive, anti-GM2 IgM positive, anti-GM1 IgM positive | IVIG (0.4g/kg/day for 5 days) | No | Survived (4) |

*AIDP, acute inflammatory demyelinating polyneuropathy; AMAN, acute motor axonal neuropathy; AMSAN, acute motor and sensory axonal neuropathy; BP, blood pressures; CSF, cerebral spinal fluid; GBS, Guillain-Barré Syndrome; IVIG, Intravenous immunoglobulin; MFS, Miller-Fisher Syndrome; NA, not available.

†The Brighton Criteria is a diagnostic tool for GBS, ranging from level 1 (highest level) to level 4 (lowest level) of diagnostic certainty by assessing the patient’s clinical presentation, cerebrospinal fluid data and nerve conduction velocity findings.

‡GBS Disability Scale grades the patient’s functional disability from 0 (healthy) to 6 (dead).

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