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Updated Proposed Brighton Collaboration process for developing a standard case definition for study of newclinical syndrome X, as applied to Thrombosis with Thrombocytopenia Syndrome (TTS)

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1. Since at least mid-February, 2021, multiple European countries (e.g., Austria, Denmark, Norway, Germany, UK) and Australia have reported cases of thrombosis with thrombocytopenia syndrome (TTS) in persons who received the Astra-Zeneca (AZ) COVID-19 vaccine (1-3, 10) and more recently in the US with the Janssen vaccine (11). There is currently no standard case definition (CD) for TTS accepted for use by all countries. On Apr. 3, 2021, the British Societyof Haemotology published its Updated Guidance on Management. Version 1.0 with CD for possible, probable, and definite cases of TTS.(4) This document is oriented towards identification and treatment of cases rather than being designed for epidemiologic studies, especially initial case finding, however. Therefore, there is an urgent need for the latter a draft of which is included in 4 below
2. Since its inception in 1999, the Brighton Collaboration has sought to advance the science of vaccine safety by developing standard CD for adverse events following immunizations (AEFI's).(5) To date, >60 CD's have been developed, such as fever, seizure, anaphylaxis, intussusception, narcolepsy, etc. Individual CD for thrombosis (6) and for thrombocytopenia (7) have also been developed.
   2.1. Based on this experience, we propose a two-step process (see 3.0) to develop both:
      2.1.1.a "draft interim case definition" to facilitate identifying a cohort of individuals withthis clinical entity (see 3.1 for process; 4.0 for draft); who could then be studied using a common study protocol and assessment tools.
         2.1.1.1.While others have called this new syndrome Vaccine-induced immune thrombotic thrombocytopenia (VITT) (1,2); this assumes a causal mechanism. We have elected to use 'thrombosis with thrombocytopenia syndrome' (TTS) (3) for this initial case finding purpose.
         2.1.1.2.To this end, vaccination with a SARS-2-CoV vaccine would not be required to enter this cohort but clearly vaccine exposure information would be collected on

these individuals along with other variables and laboratory tests that have yet tobe fully identified (see 3.2).

2.1.2. a final Brighton case definition (see 3.2).

2.2. When new clinical syndromes or diseases are first identified, standard CD are needed for both clinical (e.g., appropriate diagnosis, treatment) and public health (e.g., epidemiologic studies, and data harmonization) purposes. This is especially true for rare events where any misclassification will hinder scientific progress. The process for developing a final standard CD for a new illness usually takes some time requiring serial improvements of working orinterim CD as full knowledge accumulates. The US CDC CD for what came to be called Acquired Immuno-Deficiency Syndrome (AIDS) for example was initially developed in 1981 and revised in1985, 1987, and 1993 (4). The Chinese CD for COVID-19 changed seven times from Jan. 15 to Mar. 30, 2020 (5).

2.3. The Brighton CD's are usually tiered into three levels of available evidence, level one (high), level two (medium), and level three (low). This gradient in evidence might be acquired from clinical trials (high) or routine passive surveillance (low); or alternatively, tertiary referral hospital (high) vs. basic rural clinic (low). We try generally to avoid use of the terms Definite, Probable, Possible in this context as these terms are also commonly used for the strength of causal link (see 2.4), but are making an exception here as they are more concise and meaningful than not using them.

2.4. Because Brighton's overall interest is in accurate understanding of whether the vaccine exposure causes the AEFI or not; and because most AEFI's lack a unique clinical or laboratory marker to establish a causal link, the only way of demonstrating this causal link is by showing that vaccinated persons have a higher rate of the AEFI than unvaccinated persons in an unbiased manner (either from clinical trials or epidemiologic studies). Process-wise, the data for this rate comparison is usually best attained by first finding all possible cases of the specific AEFI or adverse event of special interest (AESI), then separatelyascertaining their vaccine exposure status in a blinded manner, before linking the two. As Brighton CD are designed to find all possible cases of meaning the CD in an unbiased manner relative to vaccine exposure, they do not include vaccine exposure as part of the CD.

3. Proposed process:

3.1. For interim/working CD for TTS: We initially proposed identifying a small number (e.g. 3) hematologists familiar with the recent cases of TTS in UK/Europe to join a similar number of Brighton Thrombosis Case Definition (CD) WG members. In practice, however, we found it too challenging to get busy clinicians together across multiple time zones in a hurry on short notice.Alternatively, we used a pre-organized meeting of the International Network of Special Immunization Services (INSIS) on this topic on Apr. 6, 2021 (and subsequent days via email) to draft the interim version and are now sharing it for broad peer review. We hope to finalize the interim CD within 1-2 weeks. Our initial focus is on cases with both thrombocytopenia and thrombosis. We recognize that it is possible that some individuals may experience either thrombosis or thrombocytopenia alone, but evaluation of this will separately.

3.2. For a final CD: we will:

3.2.1. review as complete a description as possible of identified TTS cases;

3.2.2. create a list of variables we wish to collect on them; we are merging questionnaires fromUK, EMA, Canada, and others and will then develop a consensus document based upon peer review.

3.2.3. organize and distribute the work to collect this information on each possible TTS case. in a timely manner. For this process, we can create a distributed database file, merging all thede-identified data from each country, protecting confidentiality yet allowing for needed analyses.

3.2.4. analyze the data to refine the Working CD with the goal of developing a formal final Brighton CD as swiftly as possible.

Please Note: While this interim case definition focuses on identifying cases that have both thrombocytopenia and thrombosis, it is possible that patients with this condition are part of a spectrum which may include thrombocytopenia alone as well as patients with thrombosis without thrombocytopenia. The existing Brighton Case Definitions can be used to identify and classify those patients for further study. The US CDC has elected to prioritize previously identified manifestations including CVST and splanchnic vein thrombosis for signal evaluation.[13] However here we have purposely used a broader definition to allow definition of what might be a broader spectrum of disease. In addition, in this revision we have attempted to address how heparin exposure should be addressed in identifying cases. Since exposure to heparin can cause HITT Syndrome or heparin induced thrombocytopenia thrombosis syndrome which clinically is similar to TTS, there was a consensus that cases should be stratified as to whether they had been exposed to heparin within 100 days of onset of their symptoms. We have therefore introduced levels 1-H, 2-H and 3-H for cases with heparin exposure in that time window. This heparin exposure could occur either before or after any vaccine exposure if any.

4. Interim Case Definition Thrombosis Thrombocytopenia Syndrome version 16

Any patient presenting with both acute venous or arterial thrombosis **AND** new onset thrombocytopenia[1] (as confirmed by both the Brighton Case Definitions for thrombocytopenia and thrombosis (6,7)[2]). The Brighton Collaboration case definition for thrombocytopenia (7) requires a platelet count of less than 150,000/ *u*l.[3] Either one of the two Thrombocytopenia levels of certainty, Level 1 or Level 2, is sufficient to satisfy the condition of Thrombocytopenia for the TTS case definition.

- The Brighton Collaboration case definition for thrombosis (6) is still undergoing final review. Currently the criteria for meeting the definition with level one certainty require confirmation by imaging, surgical, or pathology findings as specified below. Level two and three criteria are for a probable and possible case, respectively. The case definitions for probable and possible cases support case screening, identification, and inclusion from countries that may not have access to more sophisticated diagnostic studies.
- TTS cases will be classified regarding level of certainty based upon the Brighton level of certainty achieved for thrombosis.
- Cases will also be stratified as to whether the individual has had recent .1exposure to heparin.

LEVEL 1 BC THROMBOSIS THROMBOCYTOPENIA SYNDROME CASE CRITERIA

- **a platelet count of less than 150,000/ *u*l of new onset without history of receipt of heparin within 100 days[4]**

AND

Imaging study, surgical, or pathology findings consistent with thrombosis/thromboembolism

- Imaging studies include any of the following, depending on the location of the lesion[5]
  - Ultrasound – Doppler
  - Computed Tomography (CT scan) – contrast/angiography
  - Magnetic resonance venography (MRV) or arteriography (*MRA*)
  - Echocardiogram
  - Perfusion V/Q scan
  - Conventional angiography/Digital subtraction angiography

  OR
- Procedure that confirms the presence of a thrombus (e.g. Thrombectomy)

  OR
- Pathology consistent with thrombosis/thromboembolism including biopsy or autopsy

Most appropriate imaging test depends on the location of the lesion. Any of the tests listed may be used as available. Based on radiologist/expert interpretation.

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[1] Wise, Robert P., et al. "Thrombocytopenia: Case definition and guidelines for collection, analysis, and presentation of immunization safety data*Vaccine* 25.31 (2007): 5717-5724.

[2] Note: Anti-PF-4 antibodies have been included in clinical case definitions designed to identify patients for treatment. Since our goal here is to provide an interim case definition to further our understanding of the syndrome via epidemiologic studies, these tests have not been included is the interim case definition, but this information will be collected on the cases identified.

[3] For level one of the thrombocytopenia definition, either a blood smear to rule out platelet clumping or symptomatology in terms of bleeding is required. However, since with the TTS syndrome, the clinical manifestation is thrombosis and not bleeding and all cases will have thrombosis to meet the TTS definition, the requirement for a blood smear has been eliminated here.

[4] No heparin within the last 100 days. Please see reference 12 at end of this document for choice of this interval

[5] Imaging will depend on location and whether venous or arterial thrombosis is present. With venogram for venous thrombosis and head CT or CT angiogram or MRI/MRI angiogram for arterial lesions.

Beyond the presence of thrombocytopenia, additional abnormal laboratory clotting study results are not required for confirmation as they can be normal in presence of thrombotic/thromboembolic events. When present, they can be supportive of the diagnosis, including:

- D-dimer elevated above the upper limit of normal for age
- Shortened PT, PTT– below the lower limit of normal for age

LEVEL 1-H BC THROMBOSIS THROMBOCYTOPENIA SYNDROME CASE CRITERIA is the same as LEVEL 1 EXCEPT that the case has a history of heparin exposure within 100 days of symptom onset.

LEVEL 2 BC THROMBOSIS THROMBOCYTOPENIA SYNDROME CRITERIA (modified) - Probable Case

- **a platelet count of less than 150,000/ *u*l of new onset without recent history of receiving heparin within 100 days.**

AND A

Clinical Presentation Consistent with Thrombosis or Thromboembolism Event, including

- **Specific clinical syndromes including any of the following**
  - Deep vein thrombosis (DVT) – symptoms will depend on the location of the thrombosis, for example: swelling, pain, redness, or warmth of an extremity; headache, visual disturbance, seizures for sinus vein thrombosis; abdominal pain for intraabdominal thrombosis
  - Pulmonary thromboembolism (PE) - sudden onset shortness of breath, pleuritic chest pain, sudden death/pulseless electrical activity arrest [Wells criteria for scoring –based on clinical findings]
  - Stroke
  - Myocardial infarction
  - Arterial thrombosis

AND

- **Supporting Imaging or laboratory (D-dimer) findings suggestive but not definitive of thrombosis/thromboembolism including any of the following**

  - Chest radiograph
  - Echocardiogram
  - Computed tomography without contrast

OR

  - D-dimer - elevated above the upper limit of normal for age

LEVEL 2-H BC THROMBOSIS THROMBOCYTOPENIA SYNDROME CASE CRITERIA is the same as LEVEL 2 EXCEPT that the case has a history of heparin exposure within 100 days of symptom onset.

LEVEL THREE BC THROMBOSIS CRITERIA- Possible Case (Modified)

- **a platelet count of less than 150,000/ *u*l of new onset without recent history of receiving heparin within 100 days.[7]**

AND

Clinical Presentation Consistent with Thrombosis or Thromboembolism Event, including any of the following

Specific clinical syndromes (see full list in the flow diagram below):

- Deep vein thrombosis (DVT) – symptoms will depend on the location of the thrombosis, for example: swelling, pain, redness, or warmth of an extremity; headache, visual disturbance, seizures for sinus vein thrombosis; abdominal pain for intraabdominal thrombosis
- Pulmonary thromboembolism (PE) - sudden onset shortness of breath, pleuritic chest pain, sudden death/pulseless electrical activity arrest [Wells criteria for scoring –based on clinical findings]
- *Stroke*
- *Myocardial infarction*
- *Arterial thrombosis*

LEVEL 3-H BC THROMBOSIS THROMBOCYTOPENIA SYNDROME CASE CRITERIA is the same as LEVEL 3 EXCEPT that the case has a history of heparin exposure within 100 days of symptom onset.

5. **Decision tree algorithm for case-finding of Thrombocytopenia Thrombosis Syndrome (TTS)**

A. Is the platelet count <150 X 10^9/L and of new onset with no known recent exposure to heparin (within the last 100 days)

No → **Level 5: NOT a case of TTS**

YES

B. Was presence of thrombosis/thromboembolism confirmed by ≥ 1 of the following (check all that apply)?

- ☐ **Imaging Study**
  - — Ultrasound – Doppler
  - — CT scan – contrast / angiography
  - — Magnetic resonance venography or arteriography
  - — Echocardiogram
  - — Perfusion V/Q scan
  - — Conventional angiography / digital substraction angiography
- ☐ **Surgical procedure** - that confirmed presence of a thrombus (e.g. thrombectomy)
- ☐ **Pathologic examination** – including biopsy or autopsy

YES → **Level 1* (Definite case) TTS**

No

No

C. Did the clinical presentation suggest one of the specific clinical syndromes below? (check the most appropriate)

NOTE: *the italicized signs/symptoms in brackets after each are suggestive of the syndrome but not an exhaustive list; some but not all of them should be present.* **Diagnosis of the syndrome by a clinical specialist is also acceptable**

- ☐ **Cerebral venous sinus thrombosis / other Cerebral venous thrombosis** *(new onset of unexplained headache, often severe; focal cerebral dysfunction; encephalopathy; seizure)*
- ☐ **Deep vein thrombosis** *(new onset swelling usually but not always in lower extremities; localized swelling accompanied by pain [may be crampy in nature] and tenderness; reddened/discoloured/warm skin; pitting edema)*
- ☐ **Pulmonary thromboembolism** *(sudden onset: shortness of breath[at rest or on exertion], pleuritic chest pain[sudden, intense, sharp, stabbing or burning in nature, made worse by breathing/coughing/sneezing/laughing], cough +/- hemoptysis), tachypnea, tachycardia, arrhythmia, cyanosis, hypotension)*
- ☐ **Intra-abdominal thrombosis.** *(abdominal pain [may be out of proportion to physical exam findings], bloating, nausea, vomiting, diarrhea, bloody stools, ascites, hepatomegaly if hepatic vein location)*
- ☐ **Ischemic Stroke** *(sudden onset of focal neurologic deficits such as difficulty with speech [dysphasia or dysarthria], hemiparesis, ataxic gait abnormal eye movements, facial paresis)*
- ☐ **Myocardial infarction** *(chest pain [often crushing in nature], shortness of breath, arrhythmias, cyanosis, sudden death)*
- ☐ **Arter*ial Thrombosis***

YES

D. Were imaging &/or lab findings supportive of diagnosis of thrombosis / thromboembolism? (Check all that apply)

- ☐ **Chest radiograph**
- ☐ **Echocardiogram**
- ☐ **Computed tomography without contrast**
- ☐ **D-dimer (elevated above upper limit of normal for age)**

YES → **Level 2* (Probable case TTS)**

No → **Level 3* (Possible case TTS)**

Level 4: EXCLUDED: Reported as TTS but insufficient evidence to meet any level of the case

- If history of heparin within 100 days, then level 1-H, 2-H or 3-H respectively

6. Acknowledgement: We thank in advance the voluntary contributions of all the colleagues who make development of Brighton Collaboration CDs possible. We hope to post a list such contributors for TTS CD when ready.

7. References:

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