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Bacterial Meningitis Score for Children

Introduction: The bacterial meningitis score for children rules out bacterial meningitis in pediatric patients with suspected meningitis.

Points & Pearls

- The bacterial meningitis score (BMS) predicts bacterial versus aseptic etiology of meningitis in patients aged 29 days to 19 years with suspected meningitis.
- The BMS can help determine if the patient will require admission for parenteral antibiotics while awaiting cerebrospinal fluid (CSF) culture results.
- A higher BMS indicates a higher likelihood of bacterial meningitis.
- Although the score was derived and validated in a population of children aged 29 days to 19 years, the sensitivity, specificity, and negative predictive value (NPV) of the BMS decrease significantly for children aged < 2 months. Therefore, the creators of the BMS advise against using it for children who are aged < 2 months, as well as for children who have already received antibiotics prior to the lumbar puncture, are ill-appearing, or have examination findings that are indicative of an invasive bacterial infection (eg, petechiae and purpura).
- The BMS is not effective at ruling out potentially harmful nervous system infections (eg, herpes encephalitis, Lyme meningitis, tuberculous meningitis) that would require antibiotics.
- Meningococcal meningitis can present without CSF pleocytosis; thus, patients with meningococcal meningitis could be misclassified as not having inclusion criteria

for use of the BMS. It is important to perform a thorough physical examination to assess for petechiae or purpura if there is suspicion for meningococemia or meningococcal meningitis, as the CSF culture may have a false normal result in these cases.

Critical Actions

The clinician's gestalt and the patient's severity of illness and clinical presentation supersede the application of the BMS. If there is significant suspicion for bacterial meningitis, clinicians should err on the side of caution and admit the patient for observation and empiric antibiotics.

Instructions

The BMS should be used in patients aged 29 days to 19 years who have a CSF white blood cell count of ≥ 10 cells/ μ L. Do not use the BMS if the patient is critically ill, has recently received antibiotics, has a ventriculo-peritoneal shunt or has recently had neurosurgery, is immunosuppressed, or has another bacterial infection that requires antibiotics (including Lyme disease).

Evidence Appraisal

The original BMS was derived from a multicenter retrospective cohort study published by Nigrovic et al in 2007. Data were collected from 20 participating emergency departments at academic medical centers over a 3-year period. The study used the BMS to classify 3295 patients aged 29 days to 19 years who had CSF pleocytosis. Among the 1714 patients who were categorized as very low risk, 2 were found to have bacterial meningitis. Both of the misclassified patients were aged < 2 months and had *E coli* meningitis with an *E coli* urinary tract infection

CALCULATOR REVIEW AUTHOR

Cullen Clark, MD

Departments of Emergency Medicine and Pediatrics
Louisiana State University Health Sciences Center
New Orleans, LA

but a negative urinalysis. The sensitivity of the BMS for bacterial meningitis was 98.3% (95% confidence interval [CI], 94.2%-99.8%) and the NPV was 99.9% (95% CI, 99.6%-100%). The investigators attempted to refine the score using recursive partitioning, which led to a simpler model with only 3 variables, but also led to 1 additional patient with meningitis being misclassified as very low risk.

Given that the 2 misclassified patients were aged < 2 months, the investigators analyzed the BMS for a subgroup of all patients aged < 2 months and found

that the sensitivity was 92.3% (95% CI, 74.9%-99.4%) and the NPV was 99.5% (95% CI, 98.3%-99.9%).

The BMS was validated by Nigrovic et al in 2012, in a meta-analysis of studies published between 2002 and 2012 that included 4896 patients aged 29 days to 19 years. The sensitivity for bacterial meningitis was 99.3% (95% CI, 98.7%-99.7%) and the NPV was 98.3% (95% CI, 96.6%-99.3%).

In 2013, Kulik et al published a systematic review of several bacterial meningitis predictive rules. Among the studies reviewed, the authors found

Why to Use

The incidence of bacterial meningitis has dramatically declined since the advent of highly effective vaccines against some of the more common causes (eg, *Haemophilus influenzae* type b, *Streptococcus pneumoniae*). This has made it more challenging to determine which patients should be admitted for observation while awaiting CSF culture results.

The BMS helps identify patients who do not necessarily require observation due to the higher likelihood that they have aseptic (ie, spontaneously resolving) meningitis. It also helps avoid the financial burden and health risk that are associated with hospitalization for observation and administration of parenteral antibiotics.

When to Use

- The BMS can be used in pediatric patients aged 29 days to 19 years with suspected meningitis.
- Do **NOT** use the BMS if the patient:
 - » Is critically ill, requiring respiratory or vasopressor support
 - » Received antibiotics < 72 hours prior to the lumbar puncture
 - » Has a ventriculoperitoneal shunt or has recently had neurosurgery
 - » Is immunosuppressed
 - » Has proof of another bacterial infection (eg, urinary tract infection, bone infection, or known bacteremia) that warrants inpatient antibiotic therapy
 - » Has known active Lyme disease

Next Steps

For patients at very low risk for bacterial meningitis (BMS = 0):

- Consider discharging the patient with close follow-up (ideally within 24-48 hours) and return precautions explained to the caregiver, including new seizure activity, altered mental status, purpuric rash, or other concerning symptoms.
- Patients may have received a dose of empiric antibiotics after a lumbar puncture was performed if there is concern for bacterial meningitis. If no antibiotics were administered, consider giving a single dose of a long-acting antibiotic with good CSF penetration (eg, ceftriaxone) prior to discharge.

For patients with at least 1 risk factor or high clinical suspicion for bacterial meningitis (BMS > 0):

- Consider admitting the patient for observation and administration of parenteral antibiotics while awaiting CSF culture results.
- Make sure the CSF is sent for culture.
- Consider continuous monitoring of the patient's vital signs, along with performing regular neurologic examinations.
- Start administration of empiric broad-spectrum antibiotics if these were not previously administered.
- Consider expanding the antimicrobial coverage.
 - » If there is concern for herpes encephalitis, add acyclovir.
 - » If there is high clinical suspicion for tuberculous meningitis, consult with an infectious disease specialist and consider rifampin, isoniazid, pyrazinamide, and a fluoroquinolone or aminoglycoside.
- Consider steroid administration based on the patient's clinical presentation, the geographic area, and any potential risk factors.

Abbreviations: BMS, bacterial meningitis score; CSF, cerebrospinal fluid.

that the BMS had the highest quality of evidence and the best performance to date, but they still recommended that the score be further evaluated with prospective trials.

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Calculator Creator

Lise Nigrovic, MD, MPH

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Contact EB Medicine:

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Contact MD Aware:

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12 East 20th Street, 5th Floor
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