



OPEN ACCESS



## Diagnosis of elevated intracranial pressure in critically ill adults: systematic review and meta-analysis

Shannon M Fernando,<sup>1,2</sup> Alexandre Tran,<sup>3,4</sup> Wei Cheng,<sup>5</sup> Bram Rochweg,<sup>6,7</sup> Monica Taljaard,<sup>3,5</sup> Kwadwo Kyeremanteng,<sup>1,5</sup> Shane W English,<sup>1,3,5</sup> Mypinder S Sekhon,<sup>8</sup> Donald E G Griesdale,<sup>8,9,10</sup> Dar Dowlathahi,<sup>3,5,11</sup> Victoria A McCredie,<sup>12,13</sup> Eelco F M Wijdicks,<sup>14</sup> Saleh A Almenawer,<sup>15</sup> Kenji Inaba,<sup>16</sup> Venkatakrishna Rajajee,<sup>17,18</sup> Jeffrey J Perry<sup>2,3,5</sup>

For numbered affiliations see end of the article.

Correspondence to: S M Fernando, Department of Emergency Medicine and Department of Critical Care Medicine, The Ottawa Hospital, Civic Campus, 1053 Carling Avenue, Ottawa, ON K1Y 4E9, Canada; [sfernando@qmed.ca](mailto:sfernando@qmed.ca) (or @shanfernando on Twitter); ORCID 0000-0003-4549-4289

Additional material is published online only. To view please visit the journal online.

Cite this as: *BMJ* 2019;366:l4225 <http://dx.doi.org/10.1136/bmj.l4225>

Accepted: 30 May 2019

### ABSTRACT

#### OBJECTIVES

To summarise and compare the accuracy of physical examination, computed tomography (CT), sonography of the optic nerve sheath diameter (ONSD), and transcranial Doppler pulsatility index (TCD-PI) for the diagnosis of elevated intracranial pressure (ICP) in critically ill patients.

#### DESIGN

Systematic review and meta-analysis.

#### DATA SOURCES

Six databases, including Medline, EMBASE, and PubMed, from inception to 1 September 2018.

#### STUDY SELECTION CRITERIA

English language studies investigating accuracy of physical examination, imaging, or non-invasive tests among critically ill patients. The reference standard was ICP of 20 mm Hg or more using invasive ICP monitoring, or intraoperative diagnosis of raised ICP.

#### DATA EXTRACTION

Two reviewers independently extracted data and assessed study quality using the quality assessment of diagnostic accuracy studies tool. Summary estimates were generated using a hierarchical summary receiver operating characteristic (ROC) model.

#### RESULTS

40 studies ( $n=5123$ ) were included. Of physical examination signs, pooled sensitivity and specificity for increased ICP were 28.2% (95% confidence

interval 16.0% to 44.8%) and 85.9% (74.9% to 92.5%) for pupillary dilation, respectively; 54.3% (36.6% to 71.0%) and 63.6% (46.5% to 77.8%) for posturing; and 75.8% (62.4% to 85.5%) and 39.9% (26.9% to 54.5%) for Glasgow coma scale of 8 or less. Among CT findings, sensitivity and specificity were 85.9% (58.0% to 96.4%) and 61.0% (29.1% to 85.6%) for compression of basal cisterns, respectively; 80.9% (64.3% to 90.9%) and 42.7% (24.0% to 63.7%) for any midline shift; and 20.7% (13.0% to 31.3%) and 89.2% (77.5% to 95.2%) for midline shift of at least 10 mm. The pooled area under the ROC (AUROC) curve for ONSD sonography was 0.94 (0.91 to 0.96). Patient level data from studies using TCD-PI showed poor performance for detecting raised ICP (AUROC for individual studies ranging from 0.55 to 0.72).

#### CONCLUSIONS

Absence of any one physical examination feature is not sufficient to rule out elevated ICP. Substantial midline shift could suggest elevated ICP, but the absence of shift cannot rule it out. ONSD sonography might have use, but further studies are needed. Suspicion of elevated ICP could necessitate treatment and transfer, regardless of individual non-invasive tests.

#### REGISTRATION

PROSPERO CRD42018105642.

### WHAT IS ALREADY KNOWN ON THIS TOPIC

Elevated intracranial pressure is a complication of brain injury, including traumatic brain injury, subarachnoid haemorrhage, and intracerebral haemorrhage; left untreated, the condition can lead to cerebral ischaemia, brain herniation, and death

Definitive diagnosis requires placement of an invasive monitor, although this method is associated with complications (including haemorrhage and infection) and is not available in all settings

Therefore, clinicians often have to rely on non-invasive diagnostic tests, but the accuracy of these tests is unknown

### WHAT THIS STUDY ADDS

Independent physical examination findings (pupillary dilation, posturing, decreased level of consciousness), imaging (compression of basal cisterns, midline shift), and non-invasive tests had poor accuracy for elevated intracranial pressure

As such, these tests should not be used independently to rule out the condition. High suspicion of elevated intracranial pressure could necessitate treatment and transfer to centres capable of invasive monitor placement