QUALITY OF NEONATAL CRANIAL ULTRASOUND INTERPRETATION AMONG DOCTORS IN THE WESTERN CAPE METRO: A CLINICAL SURVEY

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BLYFIT 001

This thesis has been submitted in partial fulfilment of the requirement for the degree:

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Division of Neonatal Medicine

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Declarations

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The paper presented in this publication will be submitted to a journal for publication. The journal is accredited by the department of higher education and training. The candidate will be the first author on the paper. The candidate contributed to most to the paper. The candidate developed and wrote the paper under supervision. The candidate was involved in the analysis, presentation, and interpretation of results. Other authors and their contributions to the paper are stated in the acknowledgments section.

3rd February 2023

Acknowledgements, Format And Contributions

This dissertation is submitted in "publication-ready" format according to the most recent University of Cape Town (UCT) guidelines. The manuscript has been written according to the author guidelines for the South African Medical Journal (SAMJ) for research article submission. The SAMJ author guidelines are attached as Appendix 3. For purposes of uniformity, the entire dissertation has been formatted to the SAMJ specification of single-spaced Times New Roman font size 12. The survey that is referred to and attached as an appendix in the dissertation, will be included in the publication as online supplementary material.

I would like to acknowledge and thank my supervisors, Dr Shakti Pillay, and Professor Alan Horn for guiding me in the processes of writing the protocol, data collation, analysis and final write up. Dr Pillay conceived the project and guided the process of data collection. Both supervisors guided the other aspects and reviewed the final manuscript.

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Abstract

Background: Cranial ultrasound (cUS) is a recommended skill for paediatric and neonatal trainees in South Africa. Surveys in other countries showed inadequate knowledge and subsequently a global trend towards standards and training recommendations. There are no guidelines for training of clinicians performing cUS in South Africa.

Objectives: To survey the following aspects of cUS among paediatric and neonatal trainees at the University of Cape Town (UCT): duration of paediatric training, experience and supervision; knowledge of reporting content and procedural and technical aspects; interpretation of common neonatal cUS pathologies and confidence in scan interpretation and counselling.

Methods: An online survey was sent to all trainees, who had worked at least one month at a neonatal unit on the UCT training platform. The survey included seven questions on cUS interpretation. Procedural and image knowledge was compared between groups with ≥ 24 months' experience versus shorter duration.

Results: Thirty-one paediatric registrars and five neonatal subspecialty senior registrars were sent the survey. Twenty-six surveys were returned (72%). None of the trainees had attended a formal cUS course, 18 (69%) had attended a formal lecture from a neonatologist, and 8 (30%) had attended a formal tutorial from a consultant. Ten (38%) trainees received initial training from other registrars, medical officers, or through self-study. The components of a cUS report were stated as description of anatomy and haemorrhage by 24 (92%) and 21 (81%) respectively; only 17 (65%) mentioned ventricular size and other aspects of reporting were less frequently mentioned. Only 7 (27%) trainees knew the correct number of images to be taken in the coronal and sagittal planes. Correct identification of the major features of images ranged from 12% to 92% but was below 40% in five questions. Duration of training only affected answers in two questions; trainees with ≥ 24 months experience were more likely to correctly identify a normal scan (58% vs. 14%; p=0.038) and less likely to assign abnormal prognosis in a term baby with increased white matter echogenicity (0% vs. 43%; p=0.017).

Conclusions: Our survey shows inadequate and variable cUS training and competency in paediatric and neonatal trainees in our institution. The findings indicate the need for a structured training program and standardised diagnostic and training criteria to accredit clinicians who perform and report on neonatal cUS.

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Abbreviations

cUS: Cranial ultrasound scan

GA: Gestational age

HIE: Hypoxic ischaemic encephalopathy

HREC: Health Sciences Faculty Human Research Ethics Committee

IVH: Intraventricular haemorrhages

PMA: Post-menstrual age

PV: Periventricular

PVHD: Post haemorrhagic ventricular dilatation

PVL: Periventricular leukomalacia

UCT: University of Cape Town

UK: United Kingdom

Publication-Ready Manuscript

Quality Of Neonatal Cranial Ultrasound Interpretation Among Doctors in The Western Cape Metro: A Clinical Survey

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Quality of Neonatal Cranial Ultrasound Interpretation Among Doctors in the West Metro of Cape Town: A Clinical Survey

Background

Cranial ultrasound (cUS) is the most widely used imaging modality of the newborn brain.[1] It can detect important abnormalities, guide decisions regarding prognosis, is safe, cost-effective and accessible at the bed-side.[2, 3] Recommendations on timing and indications for neonatal cUS vary between neonatal units. The most recent standardised consensus approach was published in 2020 by the Canadian Neonatal Network (CNN) in collaboration with the Canadian Preterm Birth Network (CPTBN), and in consultation with local and international experts.[3] The guideline recommends performing at least three cUS scans in preterm babies less than 32 weeks gestational age (GA) at birth. The first cUS should be done between 4 and 7 days after birth, the second scan between 4 and 6 weeks after birth, and the third scan at approximately 36 weeks' post-menstrual age (PMA); clinical presentation and severity of pathology will influence timing of the first cUS and frequency of repeat imaging.[3] Additional indications for cUS in preterm and term babies are dependent on clinical presentation, severity of illness and extent of pathology on initial cUS.[4, 5] For a standard cUS, the whole brain should be scanned; images should be obtained through the anterior fontanelle and recorded in at least six coronal and five sagittal planes.[1] The mastoid and posterior fontanelle may be used as additional windows to improve visualisation of the posterior fossa and occipital lobes respectively.[6]

The acquisition and interpretation of cUS images are highly operator-dependent.[2] Clinicians who perform cUS should be familiar with technical aspects, relevant anatomy, pathological changes and their associated prognoses; interpretation and counselling on scan findings should be done by an experienced clinician.[5]

Neonatologists and radiologists are expected to be proficient in performing neonatal cUS and scanning is a recommended skill for paediatricians.[7-10] However, there is global variability in the level of skill and experience in cUS operators. Surveys assessing paediatric and neonatal registrars in the United Kingdom (UK) between 2001 and 2010 in terms of knowledge of cUS and training in performing and interpreting cUS, identified marked variability in skills and training received, that was largely sub-optimal, with registrars performing most after-hours cUS.[11-13] An Australian survey, in 2017, predominantly undertaken by sonographers, highlighted the divided opinions regarding optimal practice; only 13% were aware that a fixed training period or minimum number of supervised scans was a specification during training.[14] Both countries subsequently established or updated national guidelines to formalise and standardise training requirements for clinicians performing and interpreting cUS.[10, 15]

The American Academy of Pediatrics (AAP) recommend that cUS scans be performed by a board-certified sonographer and the American Institute of Ultrasound in Medicine (AIUM) states that clinicians interpreting or performing cUS should meet AIUM Training Guidelines.[16, 17]

In the public sector of South Africa, in-patient neonatal cranial ultrasound scans are performed by sonographers, radiologists, radiology registrars and paediatric and neonatal clinicians.

In the Western Cape, cUS scans are mostly performed by neonatal medical officers, paediatric registrars rotating through neonatology, neonatal senior registrars (consultant paediatricians in sub-specialist training posts), neonatologists and paediatricians. However, there are no regional or national recommendations describing training requirements and assessments of clinicians performing cUS. A survey of cUS requests by clinicians and reports by radiologists and radiology registrars in Johannesburg, South Africa, found that half the requests and reports were inadequate.[18, 19] There are no other published studies in Africa assessing cUS training or interpretative skills among doctors performing cUS in neonatal settings. The aim of this study was to survey trainee knowledge in cUS to inform the subsequent development and application of a standardised training programme in the region.

Objectives

The study objectives were to assess level of training, skills, and knowledge in performing and interpreting cUS, among paediatric registrars and neonatal senior registrars, working in tertiary and regional neonatal units in the West Metro Area of Cape Town.

Methods

Study Design and Setting

The study was a descriptive online survey of paediatric and neonatal senior registrars in the Department of Paediatrics and Child Health at the University of Cape Town (UCT). Paediatric registrars rotate through different hospitals, spending 3-months at a time at one or more of Groote Schuur Hospital (GSH), Mowbray Maternity Hospital (MMH) and New Somerset Hospital (NSH). All three hospitals provide acute neonatal care, including neonatal ventilation to the Metro West Area of Cape Town.

Convenience sampling was used as the sample size was limited by the number of registrars in the department. Registrars who had worked for at least one month in the neonatal service at any of the above hospitals on the UCT training platform, were eligible for inclusion. There were no exclusion criteria. All eligible participants who consented and did not opt out of the survey later, were included. At the time of the survey there were 31 paediatric registrars and 5 neonatal senior registrars who had previously worked at or were currently working in a neonatal service.

The study was approved by the Health Sciences Faculty Human Research Ethics Committee (HREC 102/2022) and the UCT Department of Student Affairs. The study was conducted in accordance with the principles of the Declaration of Helsinki (2013).[20]

Cranial Ultrasound Scanning Protocol

The current screening protocol for cUS scans at all three hospitals is based on the Canadian guideline.[3] Routine scans are performed in well preterm babies less than 32 weeks GA or with birth weights less than 1500 grams between day 3 and 5 and repeated on day 28 or at discharge (whichever comes first) – further scans may be indicated if either scan is abnormal.

Other indications in term and preterm babies include antenatally detected brain abnormalities, syndromes with associated central nervous system abnormalities, abnormal neurology, mechanical ventilation, sepsis, congenital infections, necrotising enterocolitis, recurrent apnoea or bradycardia, rapid decrease in haemoglobin and/or platelet counts, abnormal head growth, metabolic disorders, haemodynamic instability or acute clinical deterioration.[21]

Data Collection and Analysis

Potential trainees and their email addresses were obtained from the administrator of the UCT registrar training programme. All eligible registrars were sent an email with relevant study information, the consent statement, and a link to the on-line survey. Study participants did not receive any monetary compensation. The consent statement specified that study participation was anonymous, and that completion and submission of the survey implied voluntary consent. In addition, the survey was designed, to only commence, once the participant confirmed that they had read the consent statement, that they had completed at least one month of neonatology, and they agree to participate in the survey. Should they not respond to this mandatory statement, it would be inferred that they are opting out of participating. Participants were informed that the survey must be completed in one sitting, and they may opt out of the questionnaire at any point in the process by not completing it. The online survey was conducted using Google Forms - it was a novel tool which was first informally piloted by medical officers and consultants in the department. Questions were marked as 'required' to ensure completeness and minimise non-response bias. The cUS images were high-quality from open access publications and de-identified images from babies at GSH, where permission to use the images for teaching and publications had retrospectively been obtained.[1, 3]

The survey assessed the following:

1. Job position and year of training
2. Experience with neonatal cUS (how skills were acquired and degree of supervision)
3. Knowledge of details which should be included in cUS reporting
4. Knowledge of procedural and technical aspects of cUS
5. Interpretation of common neonatal cUS pathologies and likely outcome
6. Level of confidence in scan interpretation and parental discussion of findings

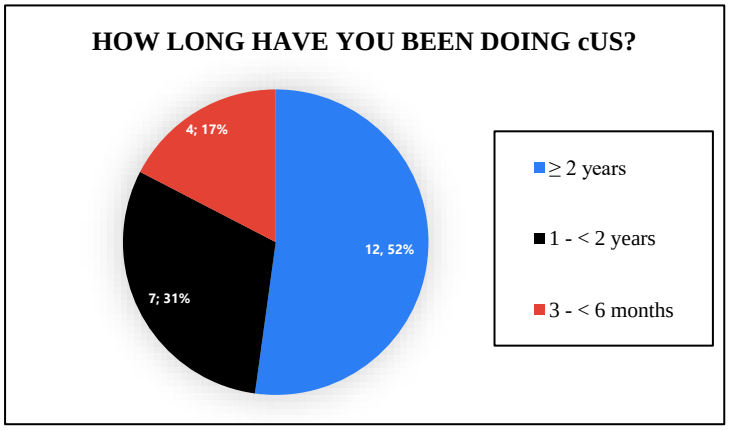
Email reminders were sent to potential participants two and four weeks after the initial email. Reminders were announced at departmental meetings and on departmental WhatsApp groups in the second month of the survey. Survey access was closed two months after the initial email. Participants were sent the answers to the seven cUS scan images, after the survey was closed. The anonymous raw data was stored in a password-protected Google account, accessible only to the researchers involved in the study. The survey is attached as Appendix 1.

Stata version 12 (Stata Corporation; College station, USA) was used for statistical analyses. Continuous variables were described as median (range) and categorical variables were described as frequencies. The procedural and image knowledge and management was compared between groups with less than 24 months experience or longer using χ^2 or Fisher's exact test for categorical variables and Wilcoxon rank sum for continuous variables. Statistical significance was assigned as $p \leq 0.05$.

Results

Thirty-one paediatric registrars and five neonatal senior registrars met inclusion criteria and were sent the online survey. Twenty-six (72%) surveys were completed and returned (22 from paediatric registrars and 4 from neonatal senior registrars). Twelve (39%) surveys were from doctors with ≥ 24 months' experience with cUS (Fig. 1)

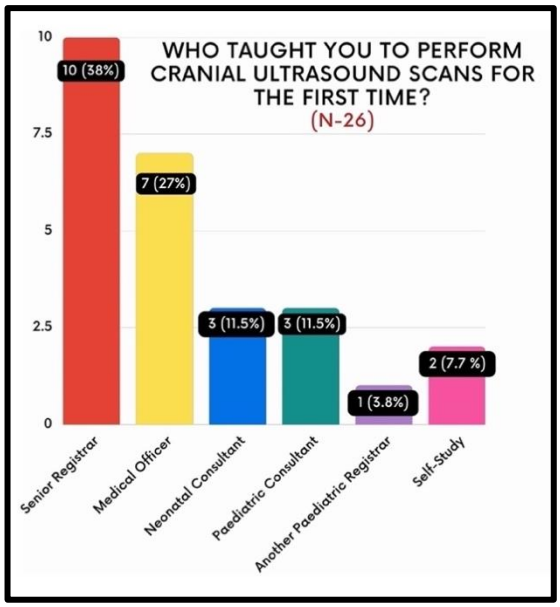
Fig. 1 Trainee Experience with Performing cUS



Training Profile of Participants

None of the participants had attended a formal cUS course; 18 (69%) had attended one formal lecture from a neonatologist, and 8 (30%) had attended a formal bedside tutorial by a consultant (paediatrician/neonatologist). Ten (38%) participants received initial training on cUS from a medical officer, paediatric registrar, or self-study (Fig. 2).

Fig. 2 Training Profile: Informal Bedside Training



The median (range) number of cUS performed per week by all participants was 3 (1-15). Only five (19%) participants discussed all scans with a supervising consultant and only 10 (38%) discussed all scans with parents. Three (12%) participants discussed cUS results with parents before discussion with the supervising consultant – all three were in their first two years of paediatric registrar training.

Knowledge Of Ultrasound Reporting

The data extracted from the free-text responses to the question, "What information should be included in the cranial ultrasound report?", are summarised in Table 1. Most participants did not include the day of life of the baby, the scan date, the name of the doctor or the name of the baby. Anatomical description, bleeding and ventricular size were described by ≥ 65%. All other aspects of the report were described by ≤ 50% of participants. Ventricular measurements were only mentioned by 35% and abnormalities/lesions, increased echogenicity or parenchymal changes were only mentioned by 19%.

Table 1. Knowledge of Cranial Ultrasound Reporting

What information should be included in the cranial ultrasound report?	**N (%)**
Day of life	5 (19%)
Date of scan	2 (8%)
Name of doctor	1 (4%)
Name of baby	2 (8%)
Limitations to scan	2 (8%)
Presence or absence of bleeds	21 (81%)
Description of anatomy/midline structures	24 (92%)
Presence or absence of flares	10 (38%)
Presence or absence of lentico-striatal vasculopathy	1 (4%)
Presence or absence of periventricular leukomalacia	6 (23%)
Poor grey/white matter differentiation	2 (8%)
Presence or absence of cysts	9 (35%)
Description of ventricular sizes	17 (65%)
Ventricular measurements	9 (35%)
Presence or absence of calcifications	7 (27%)
Description of brain maturity and/or cortical folding	13 (50%)
Description of abnormalities or obvious intracranial lesions	5 (19%)
Description of anatomy/midline structures and abnormalities/lesions	4 (15%)
Description of increased echogenicity	5 (19%)
Description of parenchymal changes	5 (19%)
Description of cerebral oedema	1 (4%)
Discussed with consultant and plan for next scan	2 (8%)
Unsure	1 (4%)

Ultrasound Procedural Knowledge

The participants' procedural knowledge of cranial ultrasound is shown Table 2. There were no significant differences in the responses relative to duration of experience.

All participants stated they were comfortable scanning through the anterior fontanelle; however less than a third knew the correct number of views in the sagittal and coronal planes. Most participants were not comfortable scanning through other cUS windows and less than half were able to set transducer frequency and focus point.

Table 2. Procedural Knowledge of Cranial Ultrasound

Question (Where applicable, values reflect trainees who answered "yes")	**N (%) / Median (Range)**			*P value
	All participants **N=26**	< 24 months cUS experience **N=14**	≥ 24 months cUS experience **N=12**	
How many anterior fontanelle views should be examined in the sagittal plane?	5 (3-7)	5 (3-7)	5 (4-7)	0.718
How many anterior fontanelle views should be examined in the coronal plane?	5 (3-9)	5 (4-6)	5 (3-9)	0.625
Are five views in sagittal and six view in coronal planes the standard number?	7 (27%)	4 (29%)	3 (25%)	1.000
Comfortable scanning through the posterior fontanelle?	4 (15%)	1 (7%)	3 (25%)	0.306
Comfortable scanning through the temporal window?	1 (4%)	1 (7%)	0	1.000
Comfortable scanning through the mastoid fontanelle?	2 (8%)	1 (7%)	1 (8%)	1.000
Able to set scan depth?	24 (92%)	12 (86%)	12 (100%)	0.483
Able to set scan area?	18 (69%)	10 (71%)	8 (67%)	1.000
Able to set scan gain?	23 (88%)	11 (79%)	12 (100%)	0.225
Able to set transducer frequency?	11 (42%)	6 (43%)	5 (42%)	1.000
Able to set focus point?	9 (35%)	4 (29%)	5 (42%)	0.683

***** Statistical significance $p \leq 0.05$.

Ultrasound Image Interpretation

The participants' knowledge of cUS image interpretation is shown in Table 3. Participants were asked to list the abnormalities shown by the image in each question or indicate that there were no abnormalities and describe the neurodevelopmental prognosis. Significant differences in the responses relative to duration of experience only occurred in questions four and six.

Question 1: Coronal and left para-sagittal images from a baby, at age 21 days, born at 26 weeks gestational age (GA). The images showed bilateral periventricular leukomalacia (PVL) involving deep/subcortical white matter (Grade 4 PVL), bilateral ventriculomegaly and resolving intraventricular haemorrhages (IVH). Cystic lesions and/or PVL were noted by most participants, however only 42% specified extensive, severe or grade 4 PVL. Dilated ventricles were noted by 58%. Only 8% described all three abnormalities. Most participants correctly described neurodevelopment as "likely to be very abnormal".

Question 2: Coronal and right para-sagittal images from a baby on the second day of life, born at 24-weeks GA. The images showed right periventricular (PV) haemorrhagic infarction (or grade 4 IVH) and the left ventricle acutely distended with > 50% filled with blood (grade 3 IVH). Periventricular haemorrhagic infarction or grade 4 IVH was noted by most participants, however less than a third correctly identified both bleeds and only 15% stated the side of the bleeds. Most participants correctly described neurodevelopment as "likely to be very abnormal."

Question 3: Coronal image from a 25-day old baby born at 28 weeks' GA. The image showed bilateral post haemorrhagic ventricular dilatation (PVHD). Participants were also asked what additional information would be useful clinically and on cUS to assess the cause and severity. Ventricular dilatation was noted by almost all participants, however ventricular and head circumference measurements were only suggested by less than a quarter. Only 54% of participants correctly described neurodevelopment as, "likely to be very abnormal".

Question 4: Coronal and left para-sagittal views from a 4-day old term baby with hypoxic ischaemic encephalopathy (HIE). The images showed increased white matter echogenicity bilaterally, increased grey/white matter differentiation, increased basal ganglia and thalamic echogenicity, and decreased internal capsule echogenicity. Less than one third of participants identified increased echogenicity in any area and none noted decreased echogenicity of the internal capsule. The terms, "oedema," "slit-like", or "small ventricles" were inappropriately used by over half of the participants. There was a significant difference in opinion regarding neurodevelopmental outcome relative to duration of experience; none of the participants with ≥ 24 months experience correctly indicated outcome was "likely to be abnormal" compared to 43% of those with < 24 months experience.

Question 5: Coronal and left and right para-sagittal images on day 4 of life from a term baby with neonatal encephalopathy at birth. The images showed a left caudothalamic cyst, PV calcifications and a right grade 1 IVH. The caudothalamic cyst was noted by more than half of participants, but only 12% specified the left side. Calcifications were only noted by one participant, but the IVH was not noted and 15% assessed the scan as normal. Neurodevelopmental outcome was correctly described as, "may be abnormal" by only 58%.

Question 6: Coronal image from a one-day old term baby with HIE. The image showed a normal scan. There was a significant difference in opinion relative to duration of experience; more than half of participants with ≥ 24 months experience correctly interpreted the scan as normal compared to only 14% of those with less experience.

Question 7: Coronal image of a term baby with seizures on day 8 of life. The image showed a focal echodensity in the medial right basal ganglia, in keeping with an infarction in the middle cerebral artery territory. An echodensity in the basal ganglia/thalamic area was noted by 65% of participants, most of whom indicated the likely cause to be infarction/stroke/bleed; however only 5 participants specified the correct side. Neurodevelopmental outcome was correctly described as, “may be abnormal” by only 54%.

Table 3. Ultrasound Image Interpretation

Images and Outcomes	N (%)			P value
	All participants **N=26**	< 24 months experience **N=14**	≥ 24 months experience **N=12**	Significance $p \leq 0.05$
Question 1				
Image findings				
Grade 4 PVL, dilated ventricles and IVH **(All abnormalities detected)**	2 (8%)	1 (7%)	1 (8%)	1.000
PVL/cystic lesions, dilated ventricles and IVH (No mention of the grade or severity of the PVL)	3 (12%)	2 (14%)	1 (8%)	1.000
PVL/cystic lesions and dilated ventricles or IVH	10 (38%)	5 (36%)	5 (42%)	1.000
Extensive or severe grade 4 PVL	11 (42%)	4 (29%)	7 (58%)	0.233
PVL/cystic lesions (No mention of grade or severity of the PVL)	8 (31%)	5 (36%)	3 (25%)	0.683
Dilated ventricles	15 (58%)	9 (64%)	6 (50%)	0.692
IVH	9 (35%)	5 (36%)	4 (33%)	1.000
Outcome				
Neurodevelopment likely to be very abnormal	20 (77%)	10 (71%)	10 (83%)	0.652
Question 2				
Image Findings				
Left grade 3 IVH, right IVH with PV haemorrhagic infarction (grade 4 IVH) **(All abnormalities detected)**	4 (15%)	1 (7%)	3 (25%)	0.306
Correct diagnosis but did not mention left or right	4 (15%)	1 (7%)	3 (25%)	0.306
Grade 3 IVH	12 (46%)	6 (43%)	6 (50%)	1.000
Grade 4 IVH	18 (69%)	8 (57%)	10 (83%)	0.216
Outcome				
Neurodevelopment likely to be abnormal	19 (73%)	10 (71%)	9 (75%)	1.000
Question 3				
Image Findings				
Ventriculomegaly/hydrocephalus	24 (92%)	12 (85%)	12 (100%)	0.483
Ventricular measurement recommended	4 (15%)	1 (7%)	3 (25%)	0.306
Head circumference measurement recommended	6 (23%)	4 (29%)	2 (17%)	0.652
All three aspects correct	1 (4%)	0	1 (8%)	0.462
Outcome				
Neurodevelopment likely to be abnormal	14 (54%)	7 (50%)	7 (58%)	0.713
Question 4				
Image Findings				
Increased white matter echogenicity	6 (23%)	3 (21%)	3 (25%)	1.000
Abnormal grey/white matter differentiation	7 (27%)	5 (36%)	2 (17%)	0.391
Increased basal ganglia echogenicity	2 (8%)	1 (7%)	1 (8%)	1.000
Increased thalamic echogenicity	4 (15%)	3 (21%)	1 (8%)	0.598
Decreased echogenicity internal capsule	0	0	0	
All 5 abnormalities correct	0	0	0	
Oedema/slit-like or small ventricles described	15 (58%)	6 (43%)	9 (75%)	0.130
Outcome				
Neurodevelopment likely to be abnormal	6 (23%)	6 (43%)	0	0.017
Question 5				
Image Findings				
Left caudothalamic cyst	3 (12%)	0	3 (25%)	0.085
Caudothalamic cyst but no side stated	0	0	0	
Cyst noted but inadequate/incorrect description	12 (46%)	6 (43%)	6 (50%)	1.000
Periventricular calcifications	1 (4%)	0	1 (8%)	0.462
Grade 1 IVH	0	0	0	
All three abnormalities correct	0	0	0	
Normal scan	4 (15%)	3 (21%)	1 (8%)	0.598
Outcome				
Neurodevelopment may be abnormal	15 (58%)	8 (57%)	7 (58%)	1.000
Question 6				
Image Findings				
Normal scan	9 (35%)	2 (14%)	7 (58%)	0.038
Oedema/slit-like or small ventricles described	11 (42%)	8 (57%)	3 (25%)	0.130
Outcome				
Normal outcome	4 (15%)	1 (7%)	3 (25%)	0.306
Question 7				
Image Findings				
Echodensity basal ganglion/thalamus	17 (65%)	9 (64%)	8 (67%)	1.000
Echodensity basal ganglion/thalamus due to infarction/stroke/bleed (with or without side specified)	16 (62%)	8 (57%)	8 (67%)	0.701
Echodensity right basal ganglion/thalamus due to infarction/stroke	5 (19%)	2 (14%)	3 (25%)	0.635
Cerebral Bleed/infarct – side/region absent/incorrect	13 (50%)	7 (50%)	6 (50%)	1.000
Outcome				
Neurodevelopment may be abnormal	14 (54%)	8 (57%)	6 (50%)	1.000

Discussion

There was a 72% response rate to this survey, assessing training and competence with cUS among paediatric and neonatal registrars in Cape Town, South Africa - the first survey of this type in Africa. More than half the candidates had less than two years' experience and there was substantial variation in the format of the cUS training and experience of the trainers. None of the candidates displayed adequate knowledge of the components to be included in an ultrasound report. Despite all candidates indicating that they were comfortable with scanning through the anterior fontanelle, most did not know the standard number of images required in each plane, nor how to adequately optimise the image. The ability to identify the major features of ultrasound images in seven questions ranged from 12% to 92% but was below 40% in most questions.

Our survey had a similar size and response rate to three surveys involving predominantly or exclusively paediatric registrars in the UK published between 2001 and 2010; the UK surveys included 32-96 registrars with response rates of 71% – 73%.[11-13] The proportion of participants with less than two years' experience with cUS in our survey was similar to the 60% of respondents in the 2010 survey – the other surveys did not specify duration of training.[13] In Australia, Lalzad et al. conducted a national survey of all professionals performing neonatal cranial ultrasound examinations in 2013 and 2014, however 88% of the 282 responses were from sonographers and subgroup analysis was not provided.[14] In 2017, Ben Fadel et al. surveyed the use of point-of-care ultrasound (POCUS) and training in all centres with neonatal-perinatal medicine training programmes in Canada; however the survey did not provide comparable data and did not focus on cUS.[22]

The format of training described in this survey was variable. Most trainees attended a formal lecture, but formal bedside tutorials were infrequent and bedside training was provided by staff, both senior and junior to the trainees. Similar variation and inadequacy of bedside training was reported in the UK surveys and performing scans without supervision was reported by 25%.[12, 13] However, approximately half of the UK registrars had attended cUS training courses compared to none of the participants in our survey.[11, 13]

The inadequate knowledge of ultrasound reporting standards, image optimisation techniques and image interpretation are not unique to our survey. In the UK, Reynolds et al. observed that almost half of their respondents were not aware of the benefit of a lower frequency probe for visualising deeper structures in term infants and correct image interpretation ranged from 45% – 71%.[13] In other UK surveys, confidence in independently performing or reporting on cUS ranged from 37% to 51%.[12, 13] The low frequency of correct image interpretation in our survey is particularly concerning since only 19% of participants discussed all scans with consultants, compared to 75% in the 2010 UK survey.[13] In addition, in our survey, neurodevelopment prognosis was only appropriately assigned by half or less than half of the participants for most questions. Fortunately, most participants in our study did not discuss findings with parents before discussing with the supervising consultant.

The authors of the UK surveys called for more structured training, measures of competency, and the implementation of existing standards; 75% of the registrars in the 2010 study were not aware of the standard published by the British society of paediatric radiology in 2003.[13] The standard suggested a minimum requirement of attendance at a theoretical course plus scanning under direct supervision until competent to scan independently.[12] The most recent UK standard for performing neonatal cUS and associated training was published in 2022 as part of a larger document, "Society of Radiographers and British Medical Ultrasound Society Guidelines for Professional Ultrasound Practice".[10] The document stipulates detailed requirements on all aspects of performing neonatal ultrasounds including safety, consent, equipment choice and management, image acquisition, storing, reporting, and indications. The guideline also endorses two further documents: the eurUS.brain summary of technique and reporting ultrasounds and the recommendations from the Royal College of Radiologists for training and competency requirements for clinicians who perform CUS infants.[1, 23] In addition to these guidelines, the British Association of Perinatal Medicine, the Royal College of Paediatrics and Child Health and the Neonatal Society are listed as supporters of the European standards of care for newborn health (ESCNH) project set up by European foundation for the care of newborn infants.[24] The ESCNH include standards for neonatal cranial ultrasound in the document, "Neurological monitoring in the high-risk infant: ultrasound and MRI scanning" – included in the medical care and clinical practice bundle. The ESCNH guidelines are also endorsed by numerous other countries in Europe, the National Perinatal Association of the USA, the Russian Society of Neonatology, the International Neonatal Association, the World Association of Perinatal Medicine, and the Union of European Neonatal and Perinatal Societies.

Several other countries and regions have established training requirements and guidelines for performing and interpreting CUS. The Australasian Society for Ultrasound in Medicine (ASUM) requires a certificate in Neonatal Clinician Performed Ultrasound (CCPU Neonatal) which is obtained after completing standardised training including courses, accredited hospital on-site training, and standardised competency assessments.[15] In 2020, the American Institute of Ultrasound in Medicine (AIUM) published, "AIUM Practice Parameter for the Performance of Neuro-sonography in Neonates and Infants" which contains guidance regarding performing neonatal CUS and training requirements.[17]

The Canadian consensus guidelines on screening and classifying preterm brain injury describe the need for CUS interpretation by an experienced specialist – training requirements are not described, however online training is available via the Calgary Neonatal Neuro-Critical Care Program.[3, 25]

In South Africa, neonatal cranial ultrasound is a required competency for the paediatric specialty and the neonatal sub-specialty.[7] There are no studies of cUS training in these disciplines and requirements have not been formalised; however the inadequate knowledge of reporting cUS as seen in our study and the lack of national guidelines was highlighted in a survey of reports by radiologists and radiology registrars in Johannesburg, where the authors proposed the use and of a cranial ultrasound reporting template.[18, 19] A potential approach to address the inadequate knowledge of registrars is for the South African Paediatric or Neonatal Association to develop and endorse an interactive video training package for national use and to include the following learning objectives in the clinical skills logbook which is a prerequisite to sit the Paediatric and Neonatology examinations of the Colleges of Medicine in South Africa: a) Details which should

be included in cUS reporting; b) Procedural and technical aspects of cUS; c) The common neonatal cUS pathologies and likely outcomes. The logbook could also include a requirement outlining the number of supervised scans for each pathology. However, this process would require an accreditation process of supervisors.

The strengths of our survey were that the duration of training was quantified and considered in the assessment; images were predominantly from peer-reviewed publications, and the 72% response rate indicates participation from most potential participants. The limitations include the potential for consultation when interpreting the images (however this was likely reduced by the anonymity and the time constraint of the survey); the limited detail of the survey (this was intentional to ensure full and representative participation) and the subjective nature of the survey that represented a cohort of trainees at one university. A nationwide survey would provide a better representation of trainees across the country.

Conclusion

The inadequate and variable cUS training and competency demonstrated in this survey, parallels both the radiologist experience in Johannesburg and the deficiencies experienced in international studies published over a decade ago.[11-13, 19] Considering the influence of cUS imaging on neonatal management and prognosis, which can have potential medico-legal consequences, this survey should provide an impetus for South African paediatric and neonatal associations and academic institutions to standardise the diagnostic and training criteria for clinicians to allow for formalised accreditation of clinicians performing and reporting on neonatal cUS.

References

1. Dudink J, Jeanne Steggerda S, Horsch S, eurUS.brain group. State-of-the-art neonatal cerebral ultrasound: technique and reporting. Pediatr Res. 2020;87(Suppl 1):3–12. http://dx.doi.org/10.1038/s41390-020-0776-y
2. Caro-Domínguez P, Lecacheux C, Hernandez-Herrera C, Llorens-Salvador R. Cranial ultrasound for beginners. Transl Pediatr. 2021;10(4):1117–1137.http://dx.doi.org/10.21037/tp-20-399
3. Mohammad K, Scott JN, Leijser LM, et al. Consensus approach for standardizing the screening and classification of preterm brain injury diagnosed with cranial ultrasound: A Canadian perspective. Front Pediatr. 2021;9. http://dx.doi.org/10.3389/fped.2021.618236
4. Beltempo M, Wintermark P, Lemyre B, et al. Predictors of severe neurologic injury on ultrasound scan of the head and risk factor-based screening for infants born preterm. J Pediatr. 2019; 214:27-33. e3. http://dx.doi.org/10.1016/j.jpeds.2019.06.065
5. van Wezel-Meijler G, Steggerda SJ, Leijser LM. Cranial ultrasonography in neonates: Role and limitations. Semin Perinatol. 2010;34(1):28–38. http://dx.doi.org/10.1053/j.semperi.2009.10.002
6. Steggerda SJ, Leijser LM, Walther FJ, van Wezel-Meijler G. Neonatal cranial ultrasonography: How to optimize its performance. Early Hum Dev. 2009;85(2):93–99. http://dx.doi.org/10.1016/j.earlhumdev.2008.11.008
7. Colleges of Medicine of South Africa (CMSA), FC Paed(SA) Portfolio and Cert.(neon) Portfolio [Internet]. [cited 2023 Jan 5]. Available from: https://www.cmsa.co.za/view_exam.aspx?QualificationID=20.
8. The Royal Australasian College of Physicians, Neonatal/Perinatal Medicine Advanced Training Curriculum Paediatrics & Child Health Division [Internet]; 2010 (revised 2013). [cited 2023 Jan 5]. Available from: https://www.racp.edu.au/docs/default-source/trainees/advanced-training/neonatal-and-perinatal-medicine/neonatal-perinatal-medicine-advanced-training-curriculum.pdf?sfvrsn=e1202c1a_10.
9. Royal College of Paediatrics and Child Health. Neonatal Medicine Syllabus, Level 3, Paediatrics Subspecialty Syllabus [Internet]; 2018. [cited 2023 Jan 5]. Available from: https://www.rcpch.ac.uk/education-careers/training/progress/curriculum
10. The Society of Radiographers. Guidelines for Professional Ultrasound Practice: 7th edition [Internet]; 2022 [cited 2023 Jan 5]. Available from: https://www.sor.org/news/ultrasound/guidelines-for-professional-ultrasound-practice-7t.
11. Reynolds PR, Dale RC, Cowan FM. Neonatal cranial ultrasound interpretation: a clinical audit. Arch Dis Child Fetal Neonatal Ed. 2001;84(2):F92-95. http://dx.doi.org/10.1136/fn.84.2.f92
12. Davis PJC, Cox RM, Brooks J. Training in neonatal cranial ultrasound: a questionnaire survey. Br J Radiol. 2005;78(925):55–56. http://dx.doi.org/10.1259/bjr/63858589
13. Banerjee J, Bhojani S, Khan A. Training and competency in neonatal cranial ultrasonography – a regional online questionnaire survey. Infant 2010;6(6):202-205.
14. Lalzad A, Wong F, Singh N, et al. Knowledge of safety, training, and practice of neonatal cranial ultrasound: A survey of operators: Neonatal cranial ultrasound: A survey of operators. J Ultrasound Med. 2018;37(6):1411–1421. http://dx.doi.org/10.1002/jum.14481

15. Australasian Society for Ultrasound in Medicine (ASUM). Certificate in Clinician Performed Ultrasound (CCPU) Neonatal [Internet]; 2022. [cited 2023 Jan 5]. Available from: https://www.asum.com.au/education/ccpu-course/ccpu-neonatal/.
16. Hand IL, Shellhaas RA, Milla SS,et al. Routine neuroimaging of the preterm brain. Pediatrics. 2020;146(5). http://dx.doi.org/10.1542/peds.2020-029082
17. AIUM practice parameter for the performance of neurosonography in neonates and infants: AIUM practice parameter for the performance of neurosonography in neonates and infants. J Ultrasound Med. 2020;39(5): E57–61. Available from: http://dx.doi.org/10.1002/jum.15264
18. Mutshutshu NP. Determination of the adequacy of cranial ultrasound requests and reports at Charlotte Maxeke Johannesburg Academic Hospital and Rahima Moosa Mother and Child Hospital (dissertation). MMed Diagnostic Radiology: University of the Witwatersrand; 2016.
19. Mutshutshu NP, Hlabangana LT. Are cranial ultrasound requests and reports adequate at two academic hospitals in Johannesburg? S Afr J Rad. 2017;21(1), a1182. https://doi.org/10.4102/sajr.v21i1.1182
20. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA 2013;310(20):2191-2194. https://doi.org/10.1001/jama.2013.281053.
21. Neonatal Guidelines and Drug Doses 2022. 6th ed. Pillay, S, editor. Cape Town: Cape Town Neonatal Consultancy; 2021.
22. Ben Fadel N, Pulgar L, F., K. Point of care ultrasound (POCUS) in Canadian neonatal intensive care units (NICUs): where are we? J Ultrasound 2019;22(2):201-206. https://doi.org/10.1007/s40477-019-00383-4.
23. Royal College of Radiologists. Ultrasound training recommendations for medical and surgical specialties [Internet]; 2022. [cited 2023 Jan 5]. 2017 [Accessed 1/1/2023]; 3rd:[Available from: https://www.rcr.ac.uk/publication/ultrasound-training-recommendations-medical-and-surgical-specialties-third-edition.
24. European standards of care for newborn health. Neurological monitoring in the high-risk infant: ultrasound and MRI scanning. 2021 [Internet]; 2022. [cited 2023 Jan 5]. A; Available from: https://newborn-health-standards.org/downloads/.
25. Calgary Neonatal Neuro-Critical Care Program [Internet]; [cited Jan]; Available from: https://nncceducation.thinkific.com.

Appendix 1: Recruitment Email and Consent Form

Introduction

Dear potential participant

I am writing to invite you to participate in an anonymous survey to assess the quality of neonatal cranial ultrasound training and interpretation among clinicians working in tertiary and secondary level neonatal intensive care units in the Western Cape. The results of the study will be published and are expected to contribute to the development and application of a neonatal cranial ultrasound training programme.

This is a consent form for research participation, and it contains important information about this study and what to expect should you decide to participate. Your participation is voluntary. Please read the form carefully.

If you agree to participate in this study, please can you click on the link below to an online survey in Google Forms. Consulting colleagues or referring to academic resources when interpreting images will compromise the objective of the study.

Voluntary Participation

Your participation in this study is voluntary. You can stop the survey at any stage. Declining to participate or withdrawing from the survey will not affect any relationships with the researchers or their academic affiliations. You will not lose any benefits to which you are otherwise entitled.

Risks and Benefits

You will not get any immediate benefit from completing this survey. The study aims to assess the quality of neonatal cranial ultrasound interpretation among doctors in the Western Cape. The data will be useful to inform the development and application of a standardised training programme in the region.

Privacy and Confidentiality

The informed consent process will be anonymous.

Ethical Clearance

Ethical clearance will be sought from the University of Cape Town's Human Research Ethics Committee and from the executive director of the Department of Student Affairs to survey the registrars.

If you wish to contact the researcher before, during or after data collection for any questions or concerns about the study you may contact them on this email address. This contact will not result in your response to the survey being associated with your identity unless you choose to disclose that information.

Appendix 2: Survey Questionnaire

Consent statement

I have read the consent statement in the email which links to this survey. I confirm that I have completed at least one month of neonatology, and I agree to participate in this survey:

o **Yes** o **No**

Part one

1. **Place of neonatal training (more than one may be selected):**

· Groote Schuur Hospital (GSH)
· Mowbray Maternity Hospital (MMH)
· New Somerset Hospital (NSH)
· Outside of UCT platform

2. **Current position in your institution:**

· Paediatric registrar year 1
· Paediatric registrar year 2
· Paediatric registrar year 3
· Paediatric registrar year 4
· Neonatology Senior Registrar year 1
· Neonatology Senior Registrar year

3. **How long have you been performing cranial ultrasound scans?**

· 3 - < 6 months
· 6-12 months
· 1- < 2 years
· ≥ 2 years

4. **On average, how many cranial ultrasound scans do you perform per week?**

5. **Do you always store the images taken?**

· Yes, I always store the images
· No, I do not store the images
· I mostly store the images but I forget to sometimes
· I only store the abnormal images

6. **If using the anterior fontanelle, how may cuts do you take in the sagittal plane?**

7. **If using the anterior fontanelle, how may cuts do you take in the coronal plane?**

8. **Have you attended a formal ultrasound training course including assessment?**

· Yes
· No

9. If yes to question 8, mention type/s of training (more than one may be selected):

- Hands-on interactive sessions using computer-based simulators
- Hands-on interactive sessions at the bedside
- Online virtual course
- Other _____

10. Who taught you to perform cranial ultrasound scans for the first time?

- Paediatric consultant
- Neonatal consultant
- Senior registrar
- Medical officer
- Radiologists
- Self-study
- Other _____

11. Have you received a formal lecture on neonatal cranial ultrasound scans?

- Yes
- No

12. Who performed the lecture (e.g., consultant/registrar)?

13. Have you received a formal bedside tutorial on neonatal cranial ultrasound scans?

- Yes
- No

14. Who performed the bed-side tutorial (e.g., consultant/registrar)?

15. How often do you discuss cranial ultrasound scans with consultants?

- Every scan you perform
- Abnormal scans only
- Only when unsure of findings
- Other _____

16. How often do you discuss your findings with parents?

- Always
- Only when the scan is abnormal
- Only when findings mandate re-direction of care
- Other _____

17. Do you discuss cranial ultrasound scans with parents before discussing the findings with a consultant?

- Yes
- No

18. Are you able to set the following on the cranial ultrasound scan machine when needed?

Scan Depth	o Yes	o No
Scan Area	o Yes	o No
Gain	o Yes	o No
Transducer frequency	o Yes	o No
Focus point	o Yes	o No

19. **How comfortable are you in using the following acoustic windows?**

Comfortable implies that you use that acoustic window as a standard for all scans performed. Not comfortable implies that you barely or never use that acoustic window for scans performed.

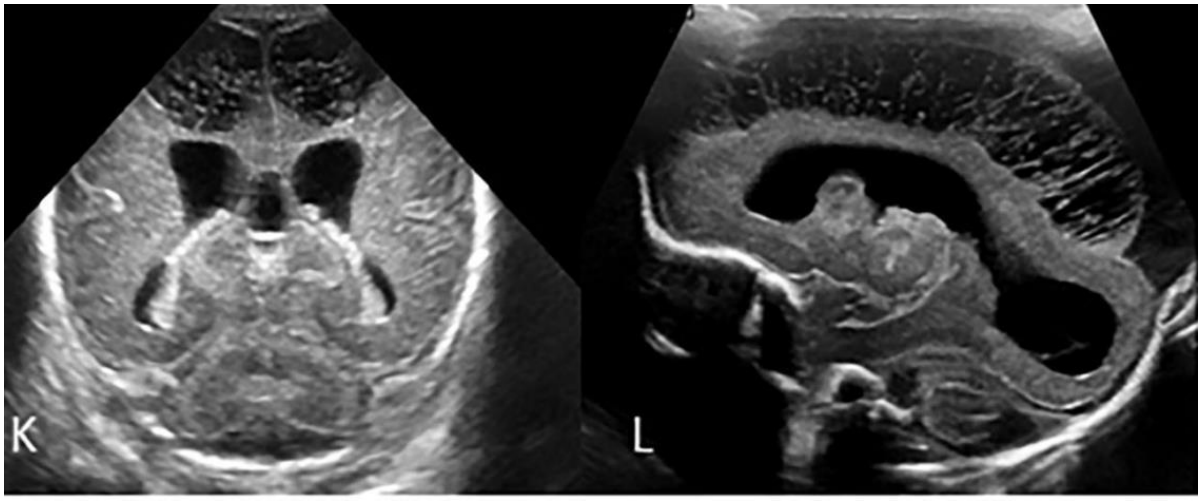
Anterior fontanelle	o Comfortable	o Not comfortable
Posterior fontanelle	o Comfortable	o Not comfortable
Temporal window	o Comfortable	o Not comfortable
Mastoid fontanelle	o Comfortable	o Not comfortable

20. Based on your experience what are the components that should be included in the cranial ultrasound report? This is a free text answer. Please document all aspects of the cranial ultrasound report that you deem important which includes what you document after every scan that you perform.

Part Two

Please interpret the following cranial ultrasound images. All images were obtained with standard cranial ultrasound settings**.** Please describe the abnormalities in as much detail as possible. If you think there are no abnormalities, you may indicate that.

Question 1. Coronal and left para-sagittal ultrasound images of a 21-day old infant born at 26-weeks gestational age.



1a. Please list the abnormality/abnormalities in the above images. If you think there are no abnormalities, you may indicate that.

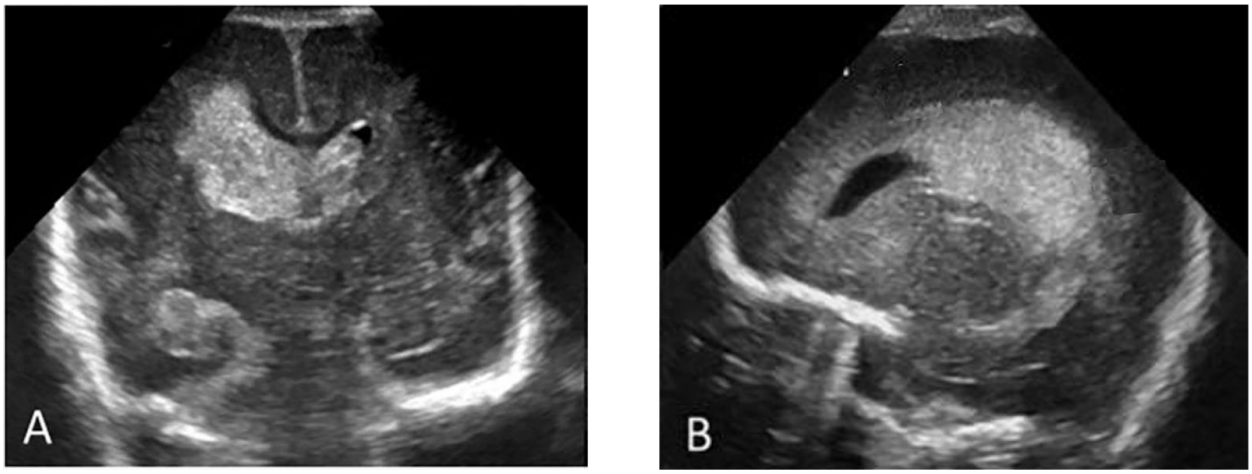
Answer:

i) Bilateral grade 4 white matter injury or PVL (periventricular leukomalacia) (or extensive cystic lesions involving deep/subcortical white matter)
ii) Bilateral ventriculomegaly
iii) Possible old intraventricular haemorrhage (IVH) bilaterally (grade difficult to assign without previous scans)

Reference: Mohammad K, Scott JN, Leijser LM, et al. Consensus Approach for Standardizing the Screening and Classification of Preterm Brain Injury Diagnosed With Cranial Ultrasound: A Canadian Perspective. Front Pediatr. 2021;9:618236. Published 2021 Mar 8. doi:10.3389/fped.2021.618236

1b. Based on your scan interpretation alone, what neurodevelopmental prognosis would you give to parents?
Normal outcome expected
Neurodevelopment may be abnormal but uncertain
Neurodevelopment very likely abnormal **(correct answer)**

Question 2. Coronal and right para-sagittal ultrasound images of a 2-day old infant born at 24-weeks gestational age**.**



2a. Please list the abnormality/abnormalities in the above images. If you think there are no abnormalities, you may indicate that.

Answer:

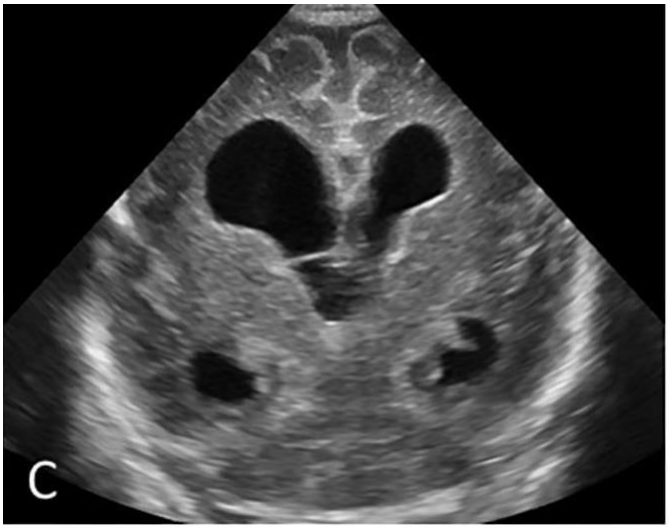
i) Right periventricular haemorrhagic infarction (previously referred to as a grade 4 IVH)
ii) Left grade 3 IVH (ventricle acutely distended and > 50% filled with blood)

Reference: Mohammad K, Scott JN, Leijser LM, et al. Consensus Approach for Standardizing the Screening and Classification of Preterm Brain Injury Diagnosed With Cranial Ultrasound: A Canadian Perspective. Front Pediatr. 2021;9:618236. Published 2021 Mar 8. doi:10.3389/fped.2021.618236

2b. Based on your scan interpretation alone, what neurodevelopmental prognosis would you give to parents?

Normal outcome expected
Neurodevelopment may be abnormal but uncertain
Neurodevelopment very likely abnormal **(correct answer**)

Question 3. Ultrasound image (coronal cut) of a 25-day old infant born at 28 weeks gestational age.



3a. Please list the abnormality/abnormalities in the above images. If you think there are no abnormalities, you may indicate that. What additional information would be useful clinically and on cranial ultrasound to assess the cause and severity?

_____

Answer:

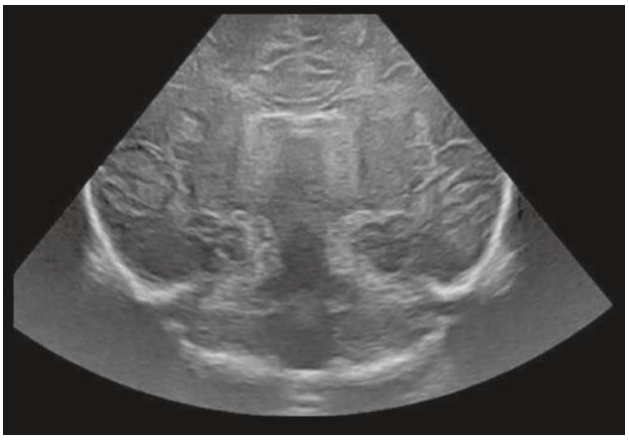
i) Bilateral ventriculomegaly – likely post haemorrhagic ventricular dilatation (PVHD).
ii) Ventricular dilatation should be quantified with measurement of lateral ventricular size using the ventricular index (VI), anterior horn width (AHW), and thalamo-occipital distance for both ventricles plotted on the appropriate chart for corrected gestational age.
iii) Head circumference trend would be useful to differentiate between PVHD and ex-vacuo dilation from volume loss.

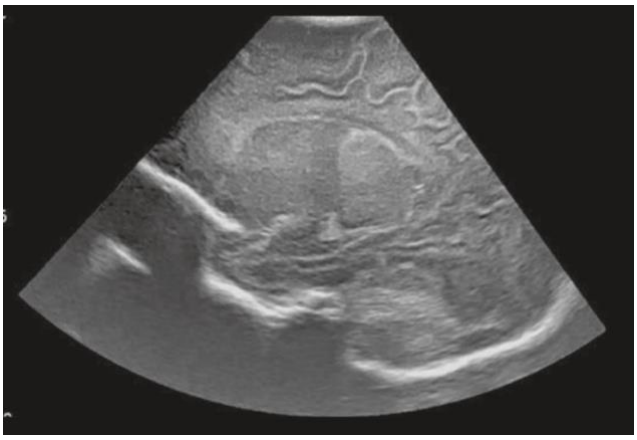
Reference: Mohammad K, Scott JN, Leijser LM, et al. Consensus Approach for Standardizing the Screening and Classification of Preterm Brain Injury Diagnosed With Cranial Ultrasound: A Canadian Perspective. Front Pediatr. 2021;9:618236. Published 2021 Mar 8. doi:10.3389/fped.2021.618236

3b. Based on your scan interpretation alone, what neurodevelopmental prognosis would you give to parents?

Normal outcome expected
Neurodevelopment may be abnormal but uncertain
Neurodevelopment very likely abnormal **(correct answer)**

Question 4: Day 4 cranial ultrasound scan - coronal and left para-sagittal view of a term infant with hypoxic encephalopathy at birth.





4a. Please list the abnormality/abnormalities in the above images. If you think there are no abnormalities, you may indicate that.

Answer:

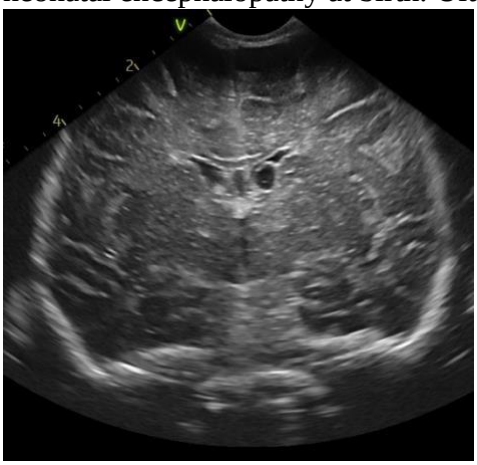
i) Increased white matter echogenicity bilaterally
ii) Increased grey/white matter differentiation
iii) Increased basal ganglia echogenicity
iv) Increased thalamic echogenicity – more than basal ganglia
v) Low echogenic internal capsule separates basal ganglia from thalamus

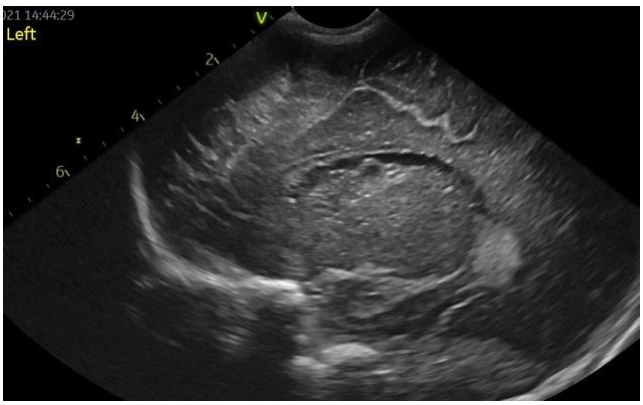
Reference: Dudink J, Jeanne Steggerda S, Horsch S, eur USbg. State-of-the-art neonatal cerebral ultrasound: technique and reporting. Pediatr Res. 2020;87(Suppl 1):3-12.

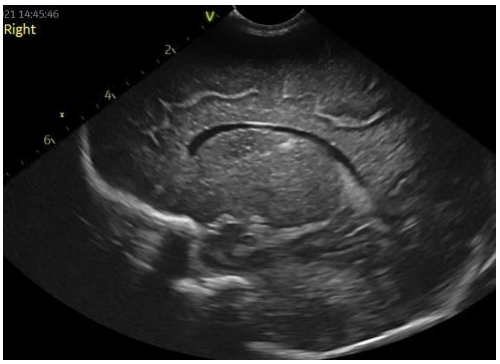
4b. Based on your scan interpretation alone, what neurodevelopmental prognosis would you give to parents?

Normal outcome expected
Neurodevelopment may be abnormal but uncertain
Neurodevelopment likely/definitely abnormal **(correct answer)**

Question 5. Coronal and left and right para-sagittal ultrasound images of a term infant with neonatal encephalopathy at birth. Ultrasound done on day 4 of life.







5a. Please list the abnormality/abnormalities in the above images. If you think there are no abnormalities, you may indicate that.

Answer:

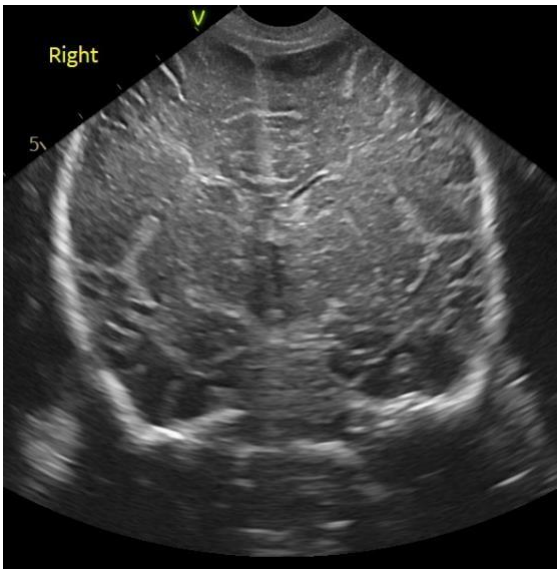
i) Left caudothalamic cyst
ii) Periventricular calcifications
iii) Right grade 1 germinal matrix haemorrhage and intraventricular haemorrhage (GMH-IVH)

Reference: Image from GSH patient with permission.

5b. Based on your scan interpretation alone, what neurodevelopmental prognosis would you give to parents?

Normal outcome expected
Neurodevelopment may be abnormal but uncertain **(correct answer)**
Neurodevelopment likely/definitely abnormal

Question 6. Day 1 ultrasound scan (coronal view) of term infant with hypoxic ischaemic encephalopathy at birth.



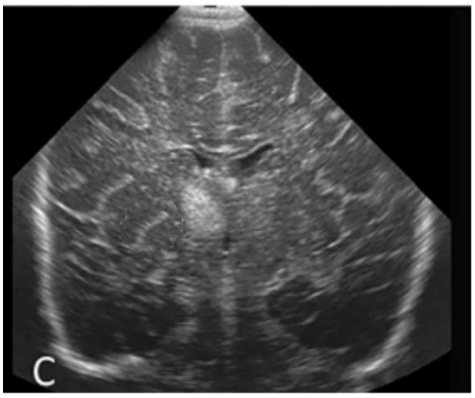
6a. Please list the abnormality/abnormalities in the above images. If you think there are no abnormalities, you may indicate that.

Answer:
i) Normal scan

Reference: Image from GSH patient with permission

6b. Based on your scan interpretation alone, what neurodevelopmental prognosis would you give to parents?
Normal outcome expected (**correct answer)**
Neurodevelopment may be abnormal but uncertain
Neurodevelopment likely/definitely abnormal

Question 7. Coronal view of term infant with seizures on day 8 of life**.**



7a. Please list the abnormality/abnormalities in the above images. If you think there are no abnormalities, you may indicate that.

Answer:

i) Focal echodensity in the medial right basal ganglion most likely an infarction (middle cerebral artery territory).

Reference: Mohammad K, Scott JN, Leijser LM, et al. Consensus Approach for Standardizing the Screening and Classification of Preterm Brain Injury Diagnosed With Cranial Ultrasound: A Canadian Perspective. Front Pediatr. 2021;9:618236. Published 2021 Mar 8. doi:10.3389/fped.2021.618236

7b. Based on your scan interpretation alone, what neurodevelopmental prognosis would you give to parents?

Normal outcome expected

Neurodevelopment may be abnormal but uncertain **(correct answer)**

Neurodevelopment likely/definitely abnormal

Appendix 3: Ethics Approval Letter

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

Room 45 E-52-E-Floor- Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6492
Email: hrec-submissions@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

15 February 2022

HREC REF: 102/2022

Dr S Pillay
Division of Neonatology
H63,H-Floor- OMB
Email: shakti.pillay@uct.ac.za
Student: fitsedememmj@gmail.com

Dear Dr Pillay

PROJECT TITLE: QUALITY OF NEONATAL CRANIAL ULTRASOUND INTERPRETATION AMONG DOCTORS IN THE WESTERN CAPE METRO: A CLINICAL SURVEY-MPHIL CANDIDATE-DR FITSUM BELAY

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee (HREC) for review.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study, subject to the following: -

1. Adding a statement that all will be confidential and anonymous.
2. Adding the FHS HREC contact details to the information document.

This approval is subject to strict adherence to the HREC recommendations regarding research involving human participants during COVID -19, our letter dated 02 February 2022 provides guidance found on our website:
http://www.health.uct.ac.za/fhs/research/humanethics/forms

Approval is granted for one year until the 28 February 2023.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

The HREC acknowledge that the student: Dr Fitsum Belay will also be involved in this study.

Please quote the HREC REF 102/2022 in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval, where necessary, before the research may occur.

Appendix 4: SAMJ Journal Requirements

General article format/layout
Accepted manuscripts that are not in the correct format specified in **Author Guidelines** http://www.samj.org.za/index.php/samj/about/submissions#authorGuidelines

Authorship
Named authors must consent to publication. Authorship should be based on: (*i*) substantial contribution to conceptualisation, design, analysis and interpretation of data; (*ii*) drafting or critical revision of important scientific content; or (*iii*) approval of the version to be published. These conditions must all be met (uniform requirements for manuscripts submitted to biomedical journals; refer to www.icmje.org)

- If authors' names are added or deleted after submission of an article, or the order of the names is changed, all authors must agree to this in writing.
- Please note that co-authors will be requested to verify their contribution upon submission. Non-verification may lead to delays in the processing of submissions.
- Author contributions should be listed/described in the manuscript.

Conflicts of interest
Conflicts of interest can derive from any kind of relationship or association that may influence authors' or reviewers' opinions about the subject matter of a paper. The existence of a conflict – whether actual, perceived or potential – does not preclude publication of an article. However, we aim to ensure that, in such cases, readers have all the information they need to enable them to make an informed assessment about a publication's message and conclusions. We require that both authors and reviewers declare all sources of support for their research, any personal or financial relationships (including honoraria, speaking fees, gifts received, etc) with relevant individuals or organisations connected to the topic of the paper, and any association with a product or subject that may constitute a real, perceived or potential conflict of interest. If you are unsure whether a specific relationship constitutes a conflict, please contact the editorial team for advice. If a conflict remains undisclosed and is later brought to the attention of the editorial team, it will be considered a serious issue prompting an investigation with the possibility of retraction.

Research ethics committee approval
Authors must provide evidence of Research Ethics Committee approval of the research where relevant. Ensure the correct, full ethics committee name and reference number is included in the manuscript.
If the study was carried out using data from provincial healthcare facilities, or required active data collection through facility visits or staff interviews, approval should be sought from the relevant provincial authorities. For South African authors, please refer to the guidelines for submission to the National Health Research Database. Research involving human subjects must be conducted according to the principles outlined in the Declaration of Helsinki. Please refer to the National Department of Health's guideline on Ethics in Health research: principles, processes and structuresto ensure that the appropriate requirements for conducting research have been met, and that the HPCSA's General Ethical Guidelines for Health Researchers have been adhered to.

Patient Consent
Information that would enable identification of individual patients should not be published in written descriptions, photographs, and pedigrees unless the information is essential for scientific purposes and the patient (or parent or guardian) has given informed written consent for publication and distribution. We further recommend that the published article is disseminated not only to the involved researchers but also to the patients/participants from whom the data was drawn. Refer to Protection of Research Participants. The signed consent form should be submitted with the manuscript to enable verification by the editorial team.

Other individuals
Any individual who is identifiable in an image must provide written agreement that the image may be used in that context in the *SAMJ*.

Copyright notice

Material submitted for publication in the *SAMJ* is accepted provided it has not been published or submitted for publication elsewhere. Please inform the editorial team if the main findings of your paper have been presented at a conference and published in abstract form, to avoid copyright infringement. All research already published as 'Conference proceedings' needs to be substantially re-written, with a new title, a new abstract and new and important results to back up any study before it will be considered for a new publication. The *SAMJ* does not hold itself responsible for statements made by the authors.

Previously published images
If an image/figure has been previously published, permission to reproduce or alter it must be obtained by the authors from the original publisher and the figure legend must give full credit to the original source. This credit should be accompanied by a letter indicating that permission to reproduce the image has been granted to the author/s. This letter should be uploaded as a supplementary file during submission.

Privacy statement
The *SAMJ* is committed to protecting the privacy of its website and submission system users. The names, personal particulars and email addresses entered in the website or submission system will not be made available to third parties without the user's permission or due process. By registering to use the website or submission system, users consent to receive communication from the *SAMJ* or its publisher SAMA on matters relating to the journal or associated publications. Queries with regard to privacy may be directed to publishing@hmpg.co.za.

Ethnic/race classification
Use of racial or ethnicity classifications in research is fraught with problems. If you choose to use a research design that involves classification of participants based on race or ethnicity, or discuss issues with reference to such classifications, please ensure that you include a detailed rationale for doing so, ensure that the categories you describe are carefully defined, and that socioeconomic, cultural and lifestyle variables that may underlie perceived racial disparities are appropriately controlled for. Please also clearly specify whether race or ethnicity is classified as reported by the patient (self-identifying) or as perceived by the investigators. Please note that is not appropriate to use self-reported or investigator-assigned racial or ethnic categories for genetic studies.

Manuscript preparation
Preparing an article for anonymous review
To ensure a fair and unbiased review process, all submissions are to include an anonymised version of the manuscript. The exceptions to this are Correspondence, Book reviews and Obituary submissions.

Submitting a manuscript that needs additional blinding can slow down your review process, so please be sure to follow these simple guidelines as much as possible:
An anonymous version should not contain any author, affiliation or particular institutional details that will enable identification.
Please remove title page, acknowledgements, contact details, funding grants to a named person, and any running headers of author names.
Mask self-citations by referring to your own work in third person.

General article format/layout
Accepted manuscripts that are not in the correct format specified in these guidelines will be returned to the author(s) for correction, which will delay publication.
General:
- Manuscripts must be written in UK English.
- The manuscript must be in Microsoft Word format. Text must be single-spaced, in 12-point Times New Roman font, and contain no unnecessary formatting (such as text in boxes).
- Please make your article concise, even if it is below the word limit.
- Qualifications, ***full*** affiliation (department, school/faculty, institution, city, country) and contact details of ALL authors must be provided in the manuscript and in the online submission process.
- Abbreviations should be spelt out when first used and thereafter used consistently, e.g. 'intravenous (IV)' or 'Department of Health (DoH)'.
- Include sections on Acknowledgements, Conflict of Interest, Author Contributions and Funding sources. If none is applicable, please state ‘none’.
- Scientific measurements must be expressed in SI units except: blood pressure (mmHg) and haemoglobin (g/dL).
- Litres is denoted with an uppercase L e.g. 'mL' for millilitres).
- Units should be preceded by a space (except for % and ºC), e.g. '40 kg' and '20 cm' but '50%' and '19ºC'.

- Please be sure to insert proper symbols e.g. µ not u for micro, a not a for alpha, b not B for beta, etc.
- Numbers should be written as grouped per thousand-units, i.e. 4 000, 22 160.
- Quotes should be placed in single quotation marks: i.e. The respondent stated: '...'
- Round brackets (parentheses) should be used, as opposed to square brackets, which are reserved for denoting concentrations or insertions in direct quotes.
- If you wish material to be in a box, simply indicate this in the text. You may use the table format –this is the *only* exception. Please DO NOT use fill, format lines and so on.
- *SAMJ* is a generalist medical journal, therefore for articles covering genetics, it is the responsibility of authors to apply the following:
- - Please ensure that all genes are in italics, and proteins/enzymes/hormones are not.
- - Ensure that all genes are presented in the correct case e.g. TP53 not Tp53.
- **NB: Copyeditors cannot be expected to pick up and correct errors wrt the above, although they will raise queries where concerned.
- - Define all genes, proteins and related shorthand terms at first mention, e.g. '188del11' can be glossed as 'an 11 bp deletion at nucleotide 188.'
- - Use the latest approved gene or protein symbol as appropriate:
- Human Gene Mapping Workshop (HGMW): genetic notations and symbols
- HUGO Gene Nomenclature Committee: approved gene symbols and nomenclature
- OMIM: Online Mendelian Inheritance in Man (MIM) nomenclature and instructions
- Bennet et al. Standardized human pedigree nomenclature: Update and assessment of the recommendations of the National Society of Genetic Counselors. J Genet Counsel 2008;17:424-433: standard human pedigree nomenclature.

Preparation notes by article type

Research
Editorials
CME
In Practice and Case reports
Reviews
Clinical trials
Correspondence
Obituaries
Book reviews
Guidelines

Research

Guideline word limit: 4 000 words

Research articles describe the background, methods, results and conclusions of an original research study. The article should contain the following sections: introduction, methods, results, discussion and conclusion, and should include a structured abstract (see below). The introduction should be concise – no more than three paragraphs – on the background to the research question, and must include references to other relevant published studies that clearly lay out the rationale for conducting the study. Some common reasons for conducting a study are: to fill a gap in the literature, a logical extension of previous work, or to answer an important clinical question. If other papers related to the same study have been published previously, please make sure to refer to them specifically. Describe the study methods in as much detail as possible so that others would be able to replicate the study should they need to. Results should describe the study sample as well as the findings from the study itself, but all interpretation of findings must be kept in the discussion section, which should consider primary outcomes first before any secondary or tertiary findings or post-hoc analyses. The conclusion should briefly summarise the main message of the paper and provide recommendations for further study.

Select figures and tables for your paper carefully and sparingly. Use only those figures that provided added value to the paper, over and above what is written in the text. Do not replicate data in tables and in text .

Structured abstract

This should be 250-400 words, with the following recommended headings:

- **Background:** why the study is being done and how it relates to other published work.
- **Objectives:** what the study intends to find out
- **Methods:** must include study design, number of participants, description of the intervention, primary and secondary outcomes, any specific analyses that were done on the data.
- **Results:** first sentence must be brief population and sample description; outline the results according to the methods described. Primary outcomes must be described first, even if they are not the most significant findings of the study.
- **Conclusion:** must be supported by the data, include recommendations for further study/actions.

Please ensure that the structured abstract is complete, accurate and clear and has been approved by all authors.

Do not include any references in the abstracts.

Here is an example of a good abstract.

Main article

All articles are to include the following main sections: Introduction/Background, Methods, Results, Discussion, Conclusions.

The following are additional heading or section options that may appear within these:

Objectives (within Introduction/Background): a clear statement of the main aim of the study and the major hypothesis tested or research question posed

Design (within Methods): including factors such as prospective, randomisation, blinding, placebo control, case control, crossover, criterion standards for diagnostic tests, etc.

Setting (within Methods): level of care, e.g. primary, secondary, number of participating centres.
Participants (instead of patients or subjects; within Methods): numbers entering and completing the study, sex, age and any other biological, behavioural, social or cultural factors (e.g. smoking status, socioeconomic group, educational attainment, co-existing disease indicators, etc)that may have an impact on the study results. Clearly define how participants were enrolled, and describe selection and exclusion criteria.
Interventions (within Methods): what, how, when and for how long. Typically for randomised controlled trials, crossover trials, and before and after studies.
Main outcome measures (within Methods): those as planned in the protocol, and those ultimately measured. Explain differences, if any.

Results
Start with description of the population and sample. Include key characteristics of comparison groups. Main results with (for quantitative studies) 95% confidence intervals and, where appropriate, the exact level of statistical significance and the number need to treat/harm.
Whenever possible, state absolute rather than relative risks.
Do not replicate data in tables and in text.
If presenting mean and standard deviations, specify this clearly. Our house style is to present this as follows:
E.g.: The mean (SD) birth weight was 2 500 (1 210) g. Do not use the ± symbol for mean (SD).
Leave interpretation to the Discussion section. The Results section should just report the findings as per the Methods section.

Discussion
Please ensure that the discussion is concise and follows this overall structure – sub-headings are not needed:
Statement of principal findings
Strengths and weaknesses of the study
Contribution to the body of knowledge
Strengths and weaknesses in relation to other studies
The meaning of the study – e.g. what this study means to clinicians and policymakers
Unanswered questions and recommendations for future research

Conclusions
This may be the only section readers look at, therefore write it carefully. Include primary conclusions and their implications, suggesting areas for further research if appropriate. Do not go beyond the data in the article.

Illustrations/photos/scans
If illustrations submitted have been published elsewhere, the author(s) should provide consent to republication obtained from the copyright holder.
Figures must be numbered in Arabic numerals and referred to in the text e.g. '(Fig. 1)'.
Each figure must have a caption/legend: Fig. 1. Description (any abbreviations in full).
All images must be of high enough resolution/quality for print.
All illustrations (graphs, diagrams, charts, etc.) must be in PDF or jpeg form.

Ensure all graph axes are labelled appropriately, with a heading/description and units (as necessary) indicated. Do not include decimal places if not necessary e.g. 0; 1.0; 2.0; 3.0; 4.0 etc.
Scans/photos showing a specific feature e.g. *Intermediate magnification micrograph of a low malignant potential (LMP) mucinous ovarian tumour. (H&E stain).* –include an arrow to show the tumour.
Each image must be attached individually as a 'supplementary file' upon submission (not solely embedded in the accompanying manuscript) and named Fig. 1, Fig. 2, etc.

Tables
Tables should be constructed carefully and simply for intelligible data representation.
Unnecessarily complicated tables are strongly discouraged.
Large tables will generally not be accepted for publication in their entirety. Please consider shortening and using the text to highlight specific important sections, or offer a large table as an addendum to the publication, but available in full on request from the author
Embed/include each table in the manuscript Word file - do not provide separately as supplementary files.
Number each table in Arabic numerals (Table 1, Table 2, etc.) and refer to consecutively in the text.
Tables must be cell-based (i.e. not constructed with text boxes or tabs) and editable.
Ensure each table has a concise title and column headings, and include units where necessary.
Footnotes must be indicated with consecutive use of the following symbols: * † ‡ § ¶ || then ** †† ‡‡ etc.

Do not: Use [Enter] within a row to make 'new rows':
Rather:
Each row of data must have its own proper row:
Do not: use separate columns for *n* and %:
Rather:
Combine into one column, *n* (%):
Do not: have overlapping categories, e.g.:
Rather:
Use <> symbols or numbers that don't overlap:

References
NB: *Only complete, correctly formatted reference lists in Vancouver style will be accepted. Reference lists must be generated manually and not with the use of reference manager software. Endnotes must* ***not*** *be used.*
Authors must verify references from original sources.
Citations should be inserted in the text as superscript numbers between square brackets, e.g.
These regulations are endorsed by the World Health Organization,[2] and others.[3,4-6]

- All references should be listed at the end of the article in numerical order of appearance in the Vancouver style (not alphabetical order).
- Approved abbreviations of journal titles must be used; see the List of Journals in Index Medicus.
- Names and initials of all authors should be given; if there are more than six authors, the first three names should be given followed by et al.

- Volume and issue numbers should be given.
- First and last page, in full, should be given e.g.: 1215-1217 **not** 1215-17. Wherever possible, references must be accompanied by a digital object identifier (DOI) link).
- Authors are encouraged to use the DOI lookup service offered by CrossRef:
  - On the Crossref homepage, paste the article title into the 'Metadata search' box.
  - Look for the correct, matching article in the list of results.
  - Click Actions > Cite
  - Alongside 'url =' copy the URL between { }.
  - Provide as follows, e.g.: https://doi.org/10.7196/07294.937.98x

Some examples:

- *Journal references:* Price NC, Jacobs NN, Roberts DA, et al. Importance of asking about glaucoma. Stat Med 1998;289(1):350-355. http://dx.doi.org/10.1000/hgjr.182
- *Book references:* Jeffcoate N. Principles of Gynaecology. 4th ed. London: Butterworth, 1975:96-101.
- *Chapter/section in a book:* Weinstein L, Swartz MN. Pathogenic Properties of Invading Microorganisms. In: Sodeman WA, Sodeman WA, eds. Pathologic Physiology: Mechanisms of Disease. Philadelphia: WB Saunders, 1974:457-472.
- *Internet references:* World Health Organization. The World Health Report 2002 - Reducing Risks, Promoting Healthy Life. Geneva: WHO, 2002. http://www.who.int/whr/2002 (accessed 16 January 2010).
- Legal references
- Government Gazettes:
- National Department of Health, South Africa. National Policy for Health Act, 1990 (Act No. 116 of 1990). Free primary health care services. Government Gazette No. 17507:1514. 1996.
- In this example, 17507 is the Gazette Number. This is followed by :1514 - this is the notice number in this Gazette.
- Provincial Gazettes:
- Gauteng Province, South Africa; Department of Agriculture, Conservation, Environment and Land Affairs. Publication of the Gauteng health care waste management draft regulations. Gauteng Provincial Gazette No. 373:3003, 2003.
- Acts: South Africa. National Health Act No. 61 of 2003.
- Regulations to an Act: South Africa. National Health Act of 2003. Regulations: Rendering of clinical forensic medicine services. Government Gazette No. 35099, 2012. (Published under Government Notice R176).
- Bills: South Africa. Traditional Health Practitioners Bill, No. B66B-2003, 2006.
- Green/white papers: South Africa. Department of Health Green Paper: National Health Insurance in South Africa. 2011.
- Case law:
  - Rex v Jopp and Another 1949 (4) SA 11 (N).
  - Rex v Jopp and Another: Name of the parties concerned
  - 1949: Date of decision (or when the case was heard)
  - (4): Volume number SA: SA Law Reports
  - 11: Page or section number
  - (N): In this case Natal - where the case was heard.
  - Similarly, (C) woud indicate Cape, (G) Gauteng, and so on.

- NOTE: no . after the v
- *Other references (e.g. reports) should follow the same format:* Author(s). Title. Publisher place: Publisher name, year; pages.
- Cited manuscripts that have been accepted but not yet published can be included as references followed by '(in press)'.
- Unpublished observations and personal communications in the text must **not** appear in the reference list. The full name of the source person must be provided for personal communications e.g. '...(Prof. Michael Jones, personal communication)'.