The Royal College of Pathologists
Pathology: the science behind the cure

FRCPath Immunology Part 2 practical examination

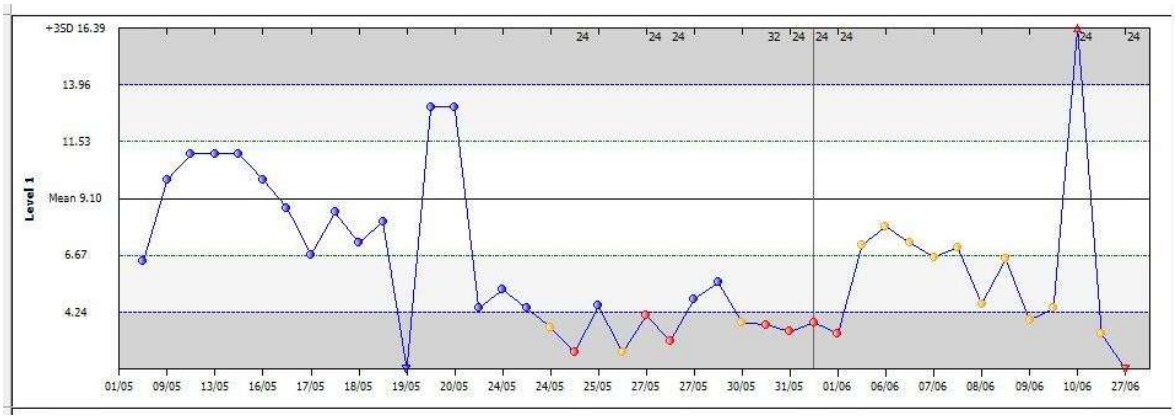
Station 2 - Quality

Two example questions are given, including the images that would have been provided on a laptop as Supplementary Material, followed by the answers.

Example question 1

You are reviewing the Levey-Jennings chart for your laboratory's internal QC for aspergillus IgG. Please review the results shown in Figure 1 and then answer the questions below.

Figure 1:



a) What is a Levey-Jennings chart and how is it used in the diagnostic laboratory? (3 marks)
b) What are Westgard rules? (1 mark)
c) Give three types of performance issue shown in Figure 1 that breach Westgard/QC rules (3 marks)
d) You discuss the IQC performance between 24/05 and 01/06 with the bench operator. They are an experienced operator and confirm that the SOP was correctly followed. Give 3 possible causes of the IQC performance issue and explain how each would have resulted in the performance seen (6 marks)
e) Following the IQC result on 27/06, the run is rejected, results are not released, and the assay is temporarily suspended pending investigation. What actions should the lab take to investigate further? (3 marks)
f) What actions should the laboratory team and clinical lead take with respect to service users and patients? (3 marks)

Example Question 2

You are reviewing your NEQAS return for Immune Monitoring Program for sample number 361. Please review Figure 2 (A-G) and then answer the questions below.

Figure 2A:

UK NEQAS
Leucocyte Immunophenotyping

Sheffield Teaching Hospitals NHS
NHS Foundation Trust

Immune Monitoring Programme
Coulter-Aquios

Distribution - 212203 | Sample - 361 | Participant ID - 40024
Date Issued - 21 October 2021 | Closing Date - 10 November 2021 | Machine Used - Aquios

Trial Comments
This exercise was issued to 848 participants.

Sample Comments
This sample was made by UK NEQAS LI using stabilised blood

Absolute Values Results and Performance

Cell Population	Your Results (cells/µL)	Robust Mean (cells/µL)	Robust SD (cells/µL)
CD3+ Lymphocytes	996.00	998.18	42.96
CD3+/CD4+ Lymphocytes	585.00	616.43	33.02
CD3+/CD8+ Lymphocytes	331.00	326.58	16.36
CD19+ Lymphocytes	147.00	147.88	33.52
CD16+/CD56+ Lymphocytes	468.00	532.99	32.34

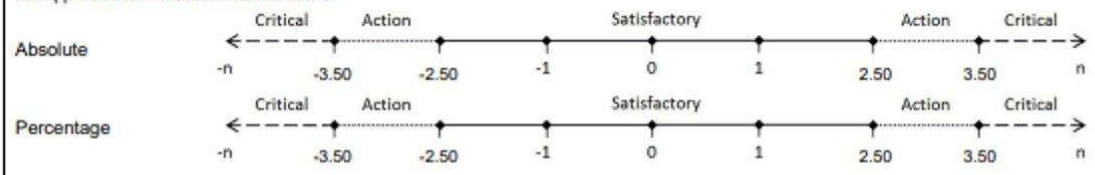
Cell Population	z Score*	Performance Status for this Sample	Performance Status Classification Over 12 Sample Period		
			Satisfactory	Action	Critical
CD3+ Lymphocytes	-0.05	Satisfactory	6	0	0
CD3+/CD4+ Lymphocytes	-0.95	Satisfactory	6	0	0
CD3+/CD8+ Lymphocytes	0.27	Satisfactory	6	0	0
CD19+ Lymphocytes	-0.03	Satisfactory	6	0	0
CD16+/CD56+ Lymphocytes	-2.01	Satisfactory	6	0	0

Percentage Values Results and Performance

Cell Population	Your Results %	Robust Mean %	Robust SD %
CD3+ Lymphocytes	58.00	57.44	1.49
CD3+/CD4+ Lymphocytes	33.00	35.03	1.28
CD3+/CD8+ Lymphocytes	18.00	18.58	0.77
CD19+ Lymphocytes	8.00	8.55	1.89
CD16+/CD56+ Lymphocytes	28.00	31.21	1.15

Cell Population	z Score*	Performance Status for this Sample	Performance Status Classification Over 12 Sample Period		
			Satisfactory	Action	Critical
CD3+ Lymphocytes	0.38	Satisfactory	6	0	0
CD3+/CD4+ Lymphocytes	-1.59	Satisfactory	6	0	0
CD3+/CD8+ Lymphocytes	-0.75	Satisfactory	6	0	0
CD19+ Lymphocytes	-0.29	Satisfactory	6	0	0
CD16+/CD56+ Lymphocytes	-2.79	Action	4	2	0

***z Score Limits Definitions**
Please note the scale below is applicable to the tables above and to the z score histograms and Shewhart control charts that follow. It is not applicable to the Cusum control charts.



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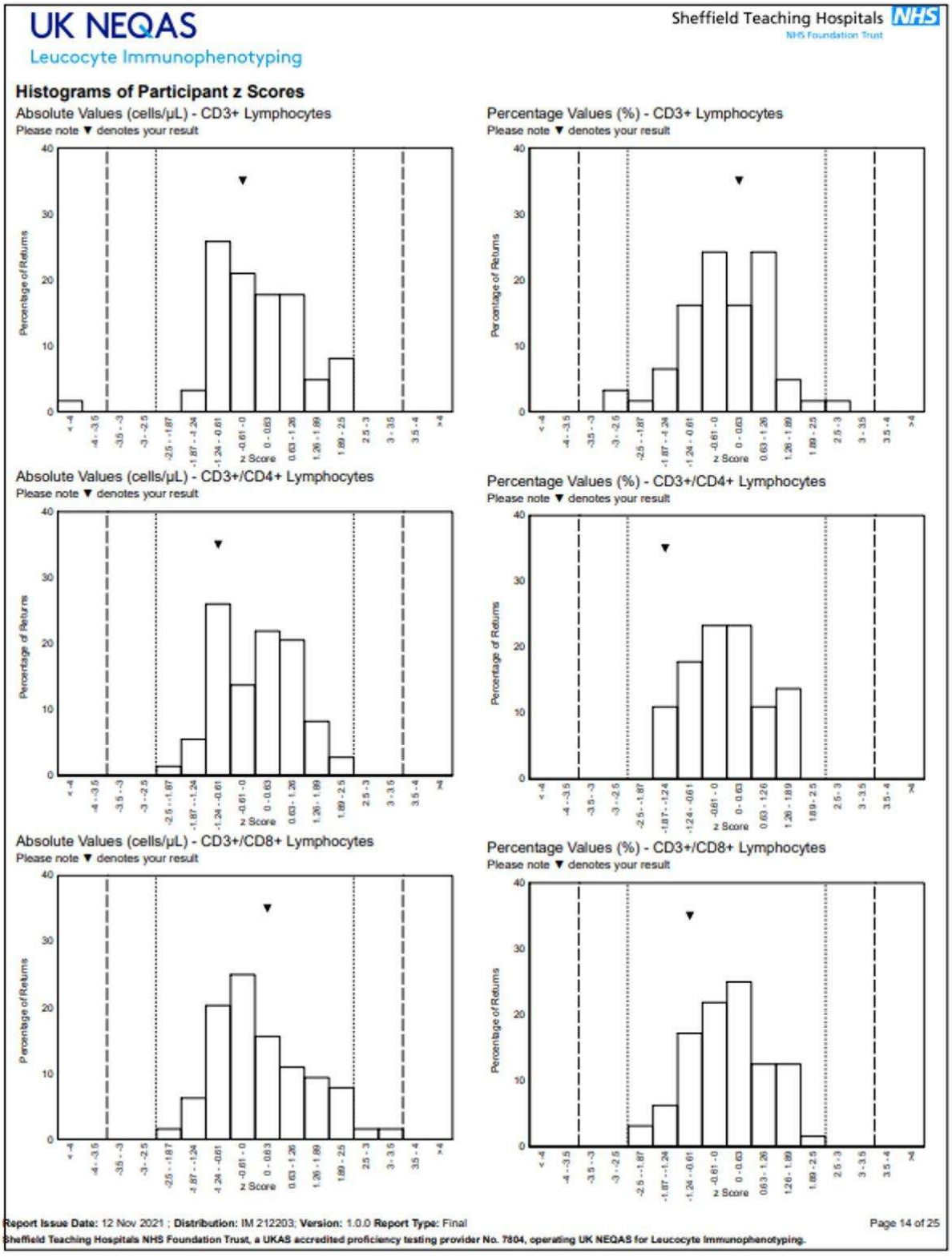
Sheffield Teaching Hospitals NHS Foundation Trust, a UKAS accredited proficiency testing provider No. 7804, operating UK NEQAS for Leucocyte Immunophenotyping.

Figure 2B:


UK NEQAS
Leucocyte Immunophenotyping
Sheffield Teaching Hospitals NHS
NHS Foundation Trust
Histograms of Participant z Scores
Absolute Values (cells/µL) - CD3+ Lymphocytes
Please note ▼ denotes your result
Percentage Values (%) - CD3+ Lymphocytes
Please note ▼ denotes your result
Absolute Values (cells/µL) - CD3+/CD4+ Lymphocytes
Please note ▼ denotes your result
Percentage Values (%) - CD3+/CD4+ Lymphocytes
Please note ▼ denotes your result
Absolute Values (cells/µL) - CD3+/CD8+ Lymphocytes
Please note ▼ denotes your result
Percentage Values (%) - CD3+/CD8+ Lymphocytes
Please note ▼ denotes your result
Percentage of Returns
z Score
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Sheffield Teaching Hospitals NHS Foundation Trust, a UKAS accredited proficiency testing provider No. 7804, operating UK NEQAS for Leucocyte Immunophenotyping.

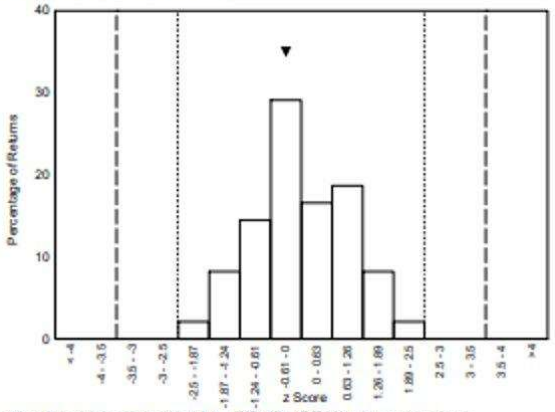
Figure 2C:

UK NEQAS
Leucocyte Immunophenotyping

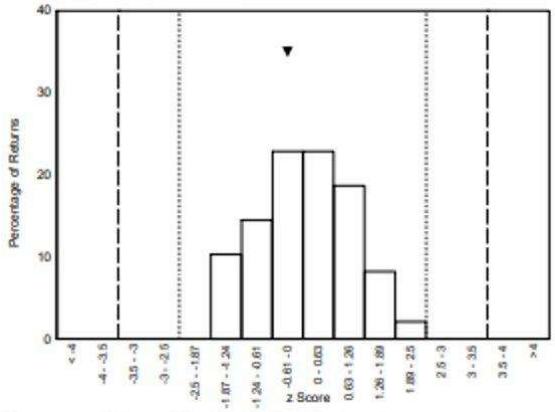
Sheffield Teaching Hospitals NHS
NHS Foundation Trust

Histograms of Participant z Scores

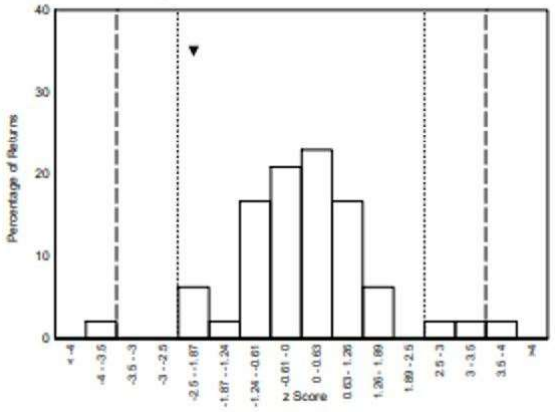
Absolute Values (cells/µL) - CD19+ Lymphocytes
Please note ▼ denotes your result



Percentage Values (%) - CD19+ Lymphocytes
Please note ▼ denotes your result



Absolute Values (cells/µL) - CD16+/CD56+ Lymphocytes
Please note ▼ denotes your result



Percentage Values (%) - CD16+/CD56+ Lymphocytes
Please note ▼ denotes your result

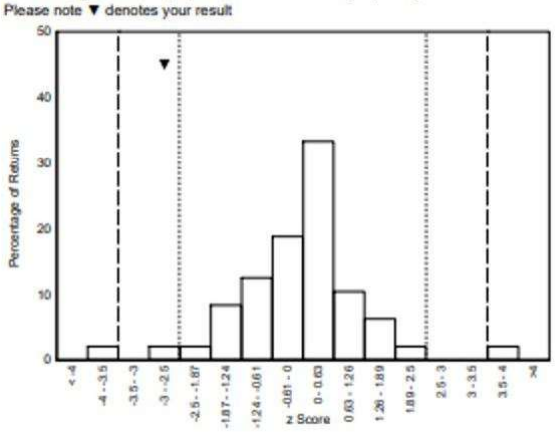


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Figure 2D:

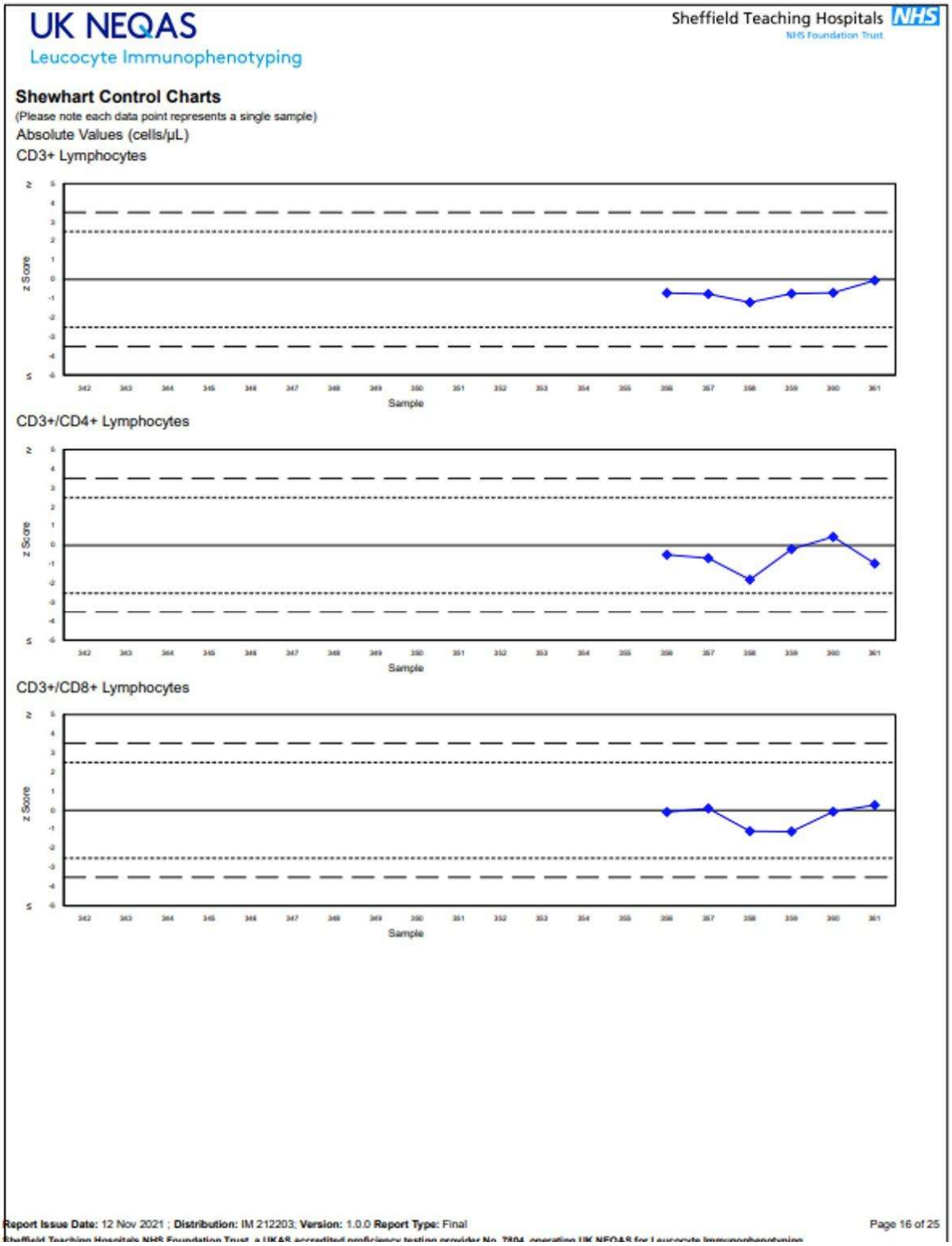
UK NEQAS
Leucocyte Immunophenotyping
Sheffield Teaching Hospitals NHS
NHS Foundation Trust
Shewhart Control Charts
(Please note each data point represents a single sample)
Absolute Values (cells/µL)
CD3+ Lymphocytes
z Score
Sample
CD3+/CD4+ Lymphocytes
z Score
Sample
CD3+/CD8+ Lymphocytes
z Score
Sample
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Figure 2E:

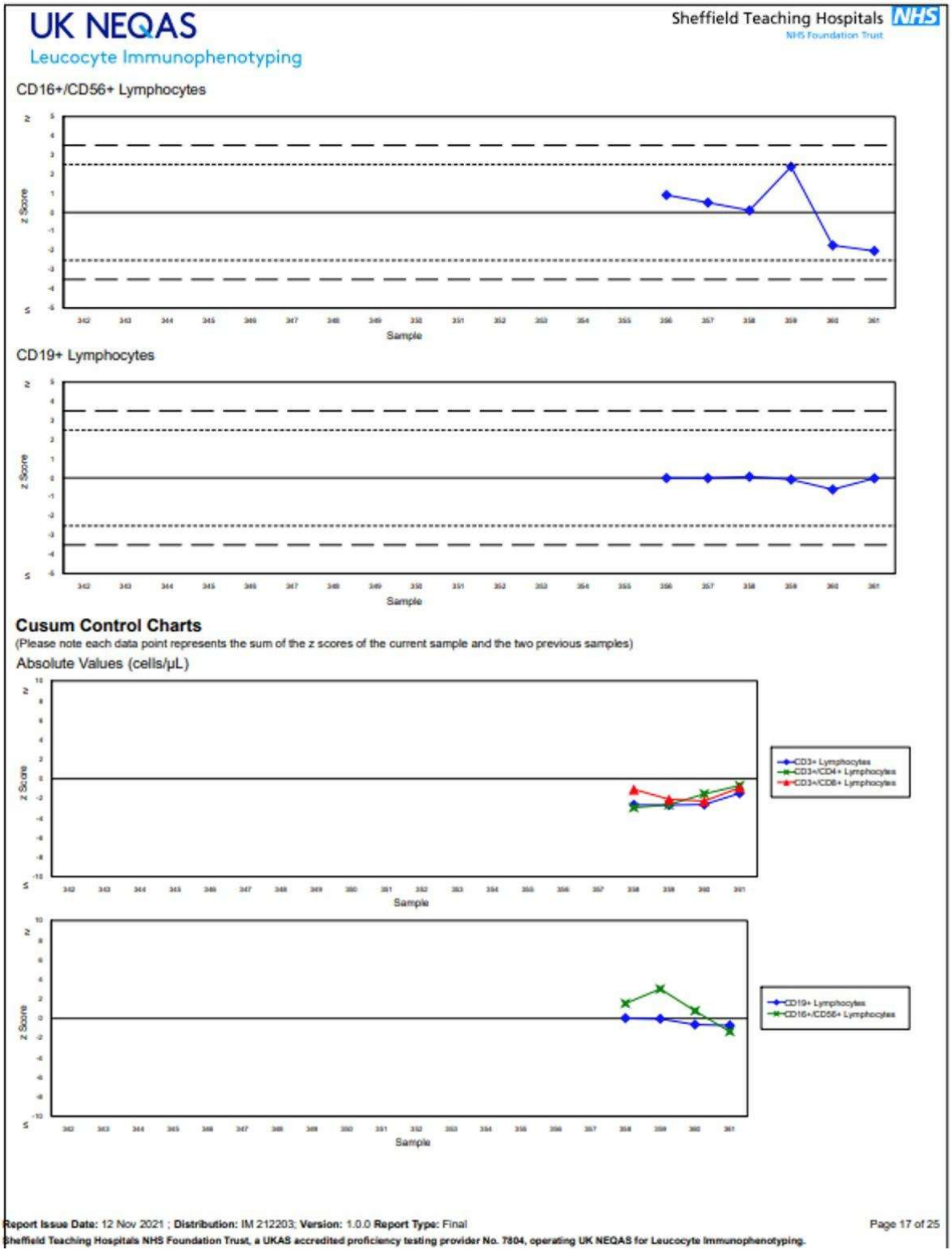
UK NEQAS
Leucocyte Immunophenotyping
Sheffield Teaching Hospitals NHS
NHS Foundation Trust
CD16+/CD56+ Lymphocytes
z Score
Sample
CD19+ Lymphocytes
z Score
Sample
Cusum Control Charts
(Please note each data point represents the sum of the z scores of the current sample and the two previous samples)
Absolute Values (cells/µL)
z Score
Sample
CD3+ Lymphocytes
CD3+/CD4+ Lymphocytes
CD3+/CD8+ Lymphocytes
z Score
Sample
CD19+ Lymphocytes
CD16+/CD56+ Lymphocytes
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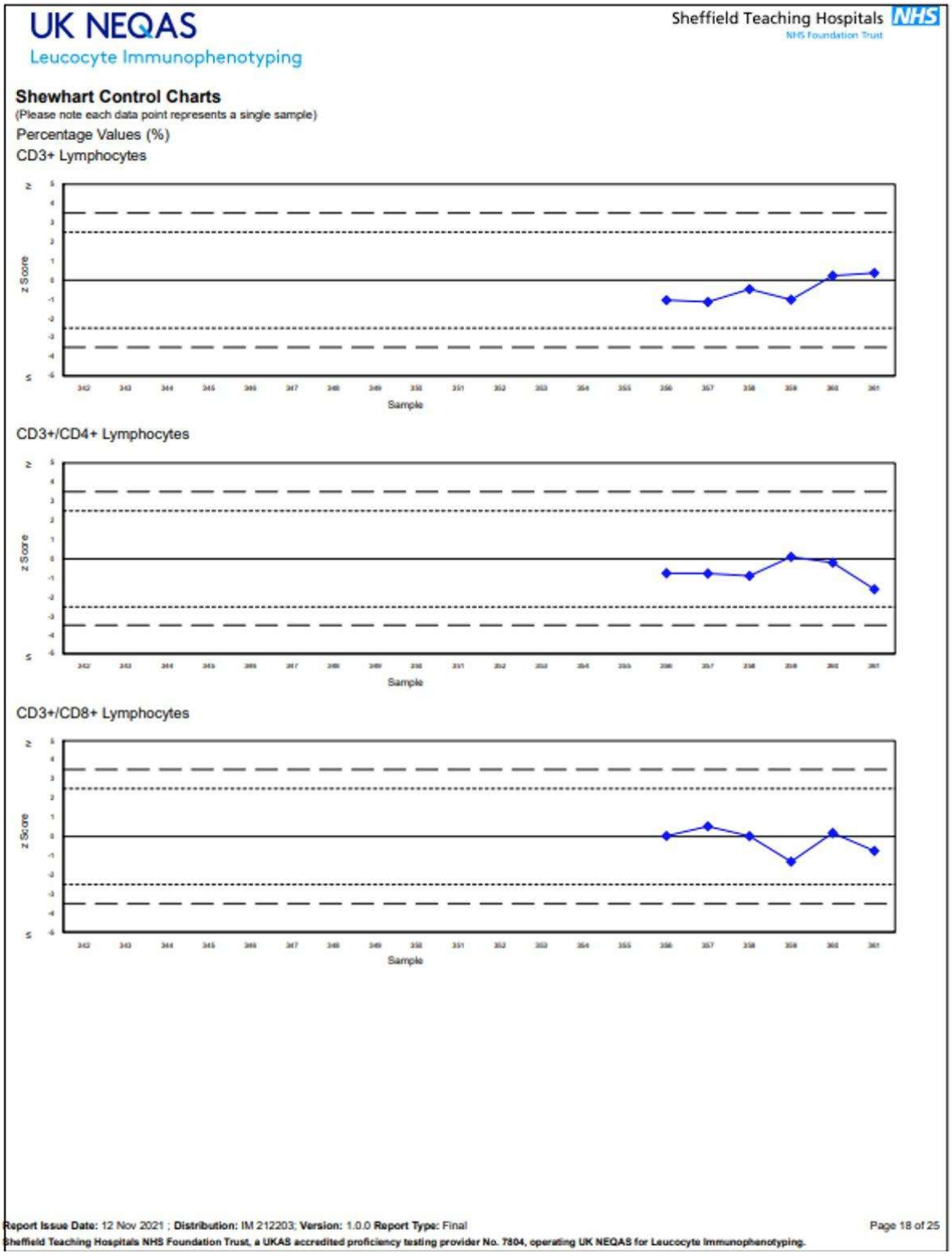
Figure 2F:


UK NEQAS
Leucocyte Immunophenotyping
Sheffield Teaching Hospitals NHS
NHS Foundation Trust
Shewhart Control Charts
(Please note each data point represents a single sample)
Percentage Values (%)
CD3+ Lymphocytes
z Score
Sample
CD3+/CD4+ Lymphocytes
z Score
Sample
CD3+/CD8+ Lymphocytes
z Score
Sample
Report Issue Date: 12 Nov 2021 ; Distribution: IM 212203; Version: 1.0.0 Report Type: Final
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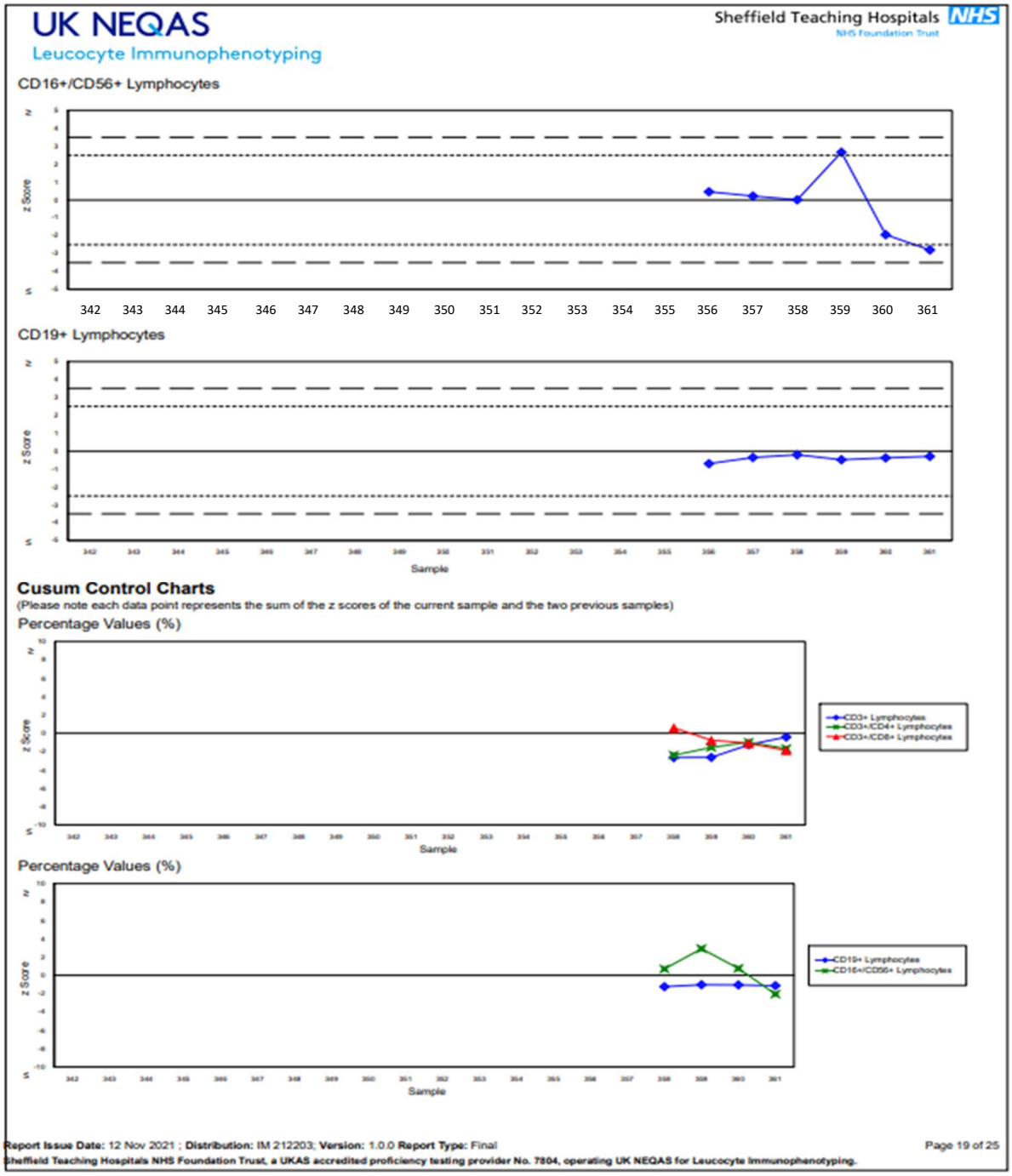
Sheffield Teaching Hospitals NHS Foundation Trust, a UKAS accredited proficiency testing provider No. 7804, operating UK NEQAS for Leucocyte Immunophenotyping.

Figure 2G:



a) What is a 'z score'? (1 mark)
b) Comment on your laboratory's z scores (4 marks)
c) What does a Shewhart control chart show? (1 mark)
d) Describe what the Shewhart control chart for CD16/CD56 lymphocytes percentage values shows (3 marks)
e) Your quality manager requests a root cause analysis into the most recent results. Describe the steps you think should be taken, including any required paperwork or communications (7 marks)

ANSWERS:

Question 1

a) Plots [QC] results against date of analysis (1 mark)
Shows mean and standard deviation / performance limits (1 mark)
Used to assess QC performance (1 mark)

b) QC rules to help analyse whether an analytical run is in-control or out-of-control, or similar (1 mark)

c) Multiple points outside 2 sd (1 mark)
Single point outside 3sd (1 mark)
>10 consecutive points on same side of mean (1 mark)

d) Three of:
Reagents (1 mark) - a new lot could have caused a shift in performance (1 mark)
Calibration (1 mark) - recalibrating the assay could have caused a shift in performance (1 mark)
QC material (1 mark) - degraded/wrong one used/error in preparing/new lot (1 mark for any of these explanations)
Maintenance/engineer (1 mark) - some maintenance procedures/replacing parts could cause a shift in performance (1 mark)

Note, although operator error is possible, you would still have to determine what the operator did wrong to create the issue seen, so is not an adequate response here.

e) Three of:
- Review paperwork to determine whether any changes in lot of reagent, calibrator or QC correlated with the poor performance OR similar (1 mark)
- Run fresh QC or new lot or similar (1 mark)
- Recalibrate assay (with fresh calibrator) (1 mark)
- Request / test a new lot of reagent (1 mark)
- Run NEQAS samples or previously analysed samples to see if see same shift [to determine if a QC issue or an assay issue] (1 mark)

f) Inform users that assay is suspended if can't resume service within a few days/a week / a suitable time frame (1 mark)
Review whether any reported results need review/retracting OR consider safety of any reported results OR similar (1 mark)
Consider clinical need for an alternative assay / sendaway if can't resolve in a clinically appropriate time frame (1 mark)

Question 2

a) Z score = (your result - robust mean) / robust SD (1 mark)
b) All cell populations' z scores are satisfactory except for one (1 mark)
   CD16+/CD56+ cells percentage has a z score of -2.79 (1 mark)
   This shows negative bias (1 mark)
   This requires investigation (1 mark)
c) Z scores for the last 20 samples (1 mark)
d) Two z scores including present distribution requiring action in the last 3 returns (1 mark)
   One with positive bias, one with negative bias (1 mark)
   Results are erratic (1 mark)
e) Review original run - check QC and gating (1 mark)
   Repeat analysis - run original samples if possible OR Request and run new samples (1 mark)
   Review IQC charts for recent performance (1 mark)
   Take appropriate corrective actions when root cause identified (1 mark)
   Consider any clinical consequences / how might have affected patient results (1 mark)
   Incident report / discuss at quality meeting / similar answer relating to recording and sharing of learning (1 mark)
   Report results of root cause analysis to NEQAS, or similar communication with NEQAS (1 mark)

Note, it is not sufficient to state ‘root cause analysis’. Candidates are expected to detail what investigations they would undertake to determine root cause and implement remedial and corrective actions, consider clinical consequences, and how this would be recorded and discussed within the department.