the current teaching methods such as slide seminars, &c. (3) No one has yet shown or even attempted to show that the main objective of improving patient care is likely to be achieved by trying to impose quality control techniques on diagnostic opinions. The morbid anatomist is more than a machine into which one can feed coloured slides at one end and expect quality controlled answers to pour out at the other. He is a doctor who consults with his clinical colleagues in arriving at diagnoses and recommending action. Through the autopsy he is also the conscience of the hospital. Increasingly he is becoming the only generalist in medicine, the only doctor who sees all aspects of serious or fatal disease. An undue or over-hasty focusing onto the small area which can be controlled or assessed may be harmful to the less assessable but not less important aspects of his work.

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Quality Control in Diagnostic Virology

Twenty years ago, there were a few specialized virus laboratories. They made most of their own reagents, and quality control was a necessary part of laboratory practice. For example, a new batch of serum was taken into use for growing cell cultures only after extensive tests to ensure that the cells grew well in it, the susceptibility of cells to viruses was checked periodically, and antigens for serological tests were titrated against appropriate sera. The demand for more widely available diagnostic services put pressure on other laboratories to do virology. As virology became more generally practised, commercial supplies of reagents of high quality became available and it was no longer necessary or practicable for every laboratory to carry out extensive quality control procedures. When the PHLS Quality Control Committee was set up in 1971, virology was included in its terms of reference and between 50 and 60 laboratories expressed a wish to participate in virus investigations. The first objective was to find out whether it was possible to help laboratories to assess and where necessary to improve their performance of virology. It was decided to distribute simulated 'specimens' to participants as was already being done in bacteriology. 'Specimens' for virus isolation were sent out from the Public Health Laboratory, Exeter, and those for serological investigation by the Standards Laboratory for Serological Reagents.

Virus Isolation

The aim was to produce information for microbiologists on the efficiency of the methods used in their laboratories for isolation and identification of various viruses.

It was decided that two or three 'specimens', each containing a single virus, should be despatched annually to participating laboratories in a form in which they could be inserted into the routine work. Simulated throat swabs were used in distributions in 1972–4. The preparation of these swabs and the selection of transport media involved a great deal of technical work. Tests were designed to show that the specimens contained adequate numbers of viable particles of the viruses inoculated into them, and no other virus. After a pilot batch had been prepared, pairs of swabs were sent to virologists in various parts of the country. Each cultured one swab and posted the other back to Exeter for culture. If difficulties were experienced in isolating the virus further experiments were performed until satisfactory 'specimens' were produced.

'Specimens' were prepared in large batches and samples were tested before the dispatch of a distribution by post to all laboratories. At least three spare specimens were posted to distant laboratories whence they were returned by post to Exeter for examination. Report forms were designed to collect information about methods used and the time required for each stage of isolation and identification.

Results

Table 1 shows the viruses sent out in 1972, 1973 and 1974 and the numbers of participating laboratories that reported on them. Laboratories were asked to report by a date set to allow them four weeks' work on each specimen. Laboratories that took less than 15 days to isolate and identify the virus in a specimen did so correctly from 93.2% of the specimens they received, but those where 15 or more days elapsed achieved only 62.6% of correct results. Some laboratories did not report on all specimens sent to them. In Table 2 the viruses have been arranged in order of difficulty according to the numbers of labora-

Table 1
Viruses sent out in 1972–4

Year	Virus	No. of laboratories: Sending reports	No. of laboratories: Isolating virus
1972	Coxsackie B5	53	51
	Echo 17	53	45
1973	Influenza A	44	34
	Parainfluenza 3	44	36
	Mumps	41	32
1974	Adenovirus 7	50	41
	Herpes simplex	49	42
	Respiratory syncytial	45	20

Table 2
Viruses arranged in order of difficulty, according to number of laboratories failing to isolate them

Virus	No. of laboratories: Reporting failure	No. of laboratories: Not reporting
Coxsackie B5	1	2
Echo 17	5	2
Herpes simplex	7	7
Parainfluenza 3	8	8
Mumps	9	9
Adenovirus 7	9	9
Influenza A	10	10
Respiratory syncytial	24	10

Table 3
Successful isolations

No. of correct isolations	No. of laboratories receiving: 8 specimens	6 specimens	3 specimens
8	11	—	—
7	11	—	—
6	7	0	—
5	10	0	—
4	3	0	—
3	4	1	1
2	3	0	2
1	2	0	0
0	1	0	0
	52	1	3

tories that failed to isolate them or did not report on the 'specimens'. Only laboratories that received all 8 specimens are considered.

The range of successful isolations is shown in Table 3. The participants changed during the trial, as a few withdrew and others joined in. Table 4 details the results from 33 laboratories that received and reported on all 8 specimens; the viruses are arranged in the same order as in Table 2 and almost the same ranking in order of difficulty appears. Table 5 shows the distribution of correct results among these 33 laboratories. The mean score was 6.6. Although 8 is a small number of specimens, the laboratories scoring 4, 3 and 2 did significantly less well than the others. Seven other laboratories also had these low scores, but did not report on one or more of the 8 specimens they received.

Immediately after the closing date, the participating laboratories were told what virus each specimen contained. Results of each distribution were sent out with comments designed to help laboratories to investigate their problems. For example, after the distribution of respiratory syncytial virus, laboratories were invited to ask the Virus Reference Laboratory for cultures of the virus so that they could check the susceptibility of their own cell lines and they were offered a supply of susceptible cells. The anonymity of laboratories was preserved in all distributions of results.

Serology

Distributions were made from the Standards Laboratory for Serological Reagents to provide information about hæmagglutination-inhibition tests for antibodies to rubella and the influenza A hæmagglutination-inhibition (HAI) and complement fixation (CF) tests. The influenza A investigation is described as an example.

Table 4
Results from 33 laboratories reporting on all 8 'specimens'

Virus	No. of laboratories reporting isolation
Coxsackie B5	33
Echo 17	30
Herpes simplex	30
Parainfluenza 3	29
Mumps	27
Adenovirus 7	26
Influenza A	27
Respiratory syncytial	15

Table 5
Results from 33 laboratories reporting on all 8 specimens

Correct isolations	No. of laboratories
8	11
7	10
6	5
5	4
4	1
3	1
2	1

Table 6
Results of HAI and CF tests for influenza A antibodies

Code	Serum	HAI	CF
A	1	1/320	1/160
B	3	1/80	1/80
C	1	1/640	1/320
D	4	< 1/10	1/10
E	1	1/640	1/160
F	2	1/160	1/160
G	2	1/160	1/80
H	1	1/640	1/160
J	3	1/160	1/80
K	2	1/320	1/160
L	3	1/80	1/80
R	4	< 1/10	1/10
S	3	1/80	1/160
W	3	1/160	1/160
X	2	1/320	1/160

Table 7
Reciprocals of titres from tests on 4 sera in 28 laboratories

	HAI		*CF*	
Serum	*Median*	*Range*	*Median*	*Range*
1	320	40–5000	320	< 10–1280
2	160	< 10–2500	160	< 10–640
3	80	20–320	80	< 10–320
4	10	< 10–1280	10	< 10–20

Table 8
Numbers of tests by 28 laboratories giving median titre within range of experimental error

	HAI		*CF*	
Serum	*No.*	*%*	*No.*	*%*
1	74/112	66	99/109	90
2	92/112	82	99/109	90
3	125/139	90	123/137	90
4	55/56	98	55/55	100

Sets of 15 ampoules of sera to be tested were issued to 28 laboratories. They were all supplied with the same batches of antigens and with *V. cholerae* filtrate to destroy nonspecific inhibitors of hæmagglutination. They used their own chick cells for the HAI test and their own complement for the CF test. Table 6 illustrates the report form used. Only four sera were in fact distributed; they were prepared from pools of human serum. Serum 1 was undiluted, sera 2 and 3 were respectively 1:2 and 1:3.25 dilutions of another pool, and serum 4 was without antibodies to the hæmagglutinin. The code letters in the left hand column of Table 6 were those on the ampoules issued to laboratories; the figures in the second column indicate which pool the ampoule contained. The titres shown are those reported from our laboratory.

Results
The median titres and the range of results of tests in the 28 participating laboratories are shown in Table 7. The results are analysed in Table 8. The results falling within twofold differences from the median titre range from 66% in HAI tests on serum 1, to 100% of CF tests with serum 4. Comparison of the results from individual laboratories show that all the titres reported by 11 laboratories in the HAI and by 16 laboratories in the CF test fell within two-fold of the medians.

Summary and Conclusions
Quality control in diagnostic virology is in its infancy and some preliminary investigations are reported. Simulated specimens containing viruses have been prepared and distributed so that they could be included in the routine work of virus isolation in participating laboratories. Sera containing antibodies to rubella and influenza virus have also been sent to laboratories for testing.

Laboratories were able to check their results immediately after the closing date, and could compare their performance with that of other laboratories when the analysis of each distribution was circulated. The results so far show considerable variation in performance and indicate that there is room for improvement in some laboratories. There is no evidence to show whether the exercise has had any effect on the practice of virology in participating laboratories but some baselines have been produced for comparison with the results of investigations in the future.

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Preparation of Quality Control Materials in Clinical Chemistry and Hæmatology

Quality control materials have interested me since they were first made available. At that time I was a user in a busy clinical laboratory. Then I spent some thirteen years of my life making controls. And now I am back as a user in a busy clinical laboratory. The possibility of looking at the problem both from the manufacturer's point of view and that of the user has, I feel, given me a sense of objectivity in evaluating the subject of my presentation.

Quality control materials for clinical chemistry were presented to the laboratory shortly after photoelectric colorimeters and spectrophotometers were being promoted and when the laboratory was experiencing the initial impact of increasing work that has now become a massive avalanche.

The initial clinical chemistry control consisted of a bovine albumin base with electrolytes (sodium, potassium, chlorides, phosphorus and calcium) and other constituents (glucose, urea, creatinine, iron) added up to normal concentrations. The

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