An Assessment of Condemnations of Broiler Chicken Carcasses

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ABSTRACT

An epidemiological study was conducted to assess the rates of condemnation and the diagnoses made on condemned broiler chicken carcasses in a federally-inspected abattoir. The first objective was to determine the predictive value of a positive test: the proportion of birds that were truly unfit for human consumption among condemned carcasses. The second objective was to assess the degree of agreement between diagnoses made in the abattoir and diagnoses determined by a detailed gross postmortem examination on the same condemned carcasses.

A two-stage convenience sampling technique was used to obtain the birds needed. Fifteen lots of birds were selected and within each of these, approximately 45 condemned carcasses were selected for a total of 680. All the diagnoses made on these birds at the abattoir were recorded and the carcasses individually identified. The sampled carcasses were transported to the Ontario Veterinary College where a panel of three federal veterinarians independently judged whether the birds were fit for human consumption. In addition, a detailed gross postmortem examination was conducted on each carcass.

An overall predictive value of a positive test of approximately 70% was found. The degree of agreement among members of the panel of examiners was also tested. The overall agreement was good (Kappa = 0.62 between examiners 1 and 2 and 0.51 between examiners 1 and 3). However, carcasses condemned for specific conditions at the abattoir, namely valgus varus deformity, mutilation, cellulitis and hepatitis showed no agreement beyond chance, while other carcasses condemned for conditions such as cyanosis and bruising showed poor agreement concerning their disposition for at least one pair of examiners. The agreement between diagnoses made at the abattoir and diagnoses made by postmortem examination was, in general, very good (Kappa from 0.67 to 0.93) except for certain conditions, including cyanosis (Kappa statistic of 0.39) and emaciation (no cases diagnosed at the Ontario Veterinary College).

RÉSUMÉ

Les auteurs ont participé à une étude épizootiologique, destinée à évaluer les taux de condamnation et les diagnostics posés sur des carcasses de poulets de gril confisquées, dans un abattoir sous inspection fédérale. Le premier objectif visait à déterminer la valeur de prédiction d'un test positif, à savoir: la proportion de carcasses confisquées, réellement impropres à la consommation humaine. Le deuxième objectif visait à évaluer le degré de concordance entre les diagnostics posés à l'abattoir et ceux qui résultaient d'un examen macroscopique approfondi des carcasses confisquées.

On utilisa une technique d'échantillonnage à deux volets pour obtenir les poulets de gril désirés. On en choisit d'abord 15 lots et, parmi chacun, environ 45 carcasses condamnées, pour un total de 680. On enregistra tous les diagnostics posés sur ces carcasses, à l'abattoir, et on les identifia individuellement; on les expédia ensuite au Collège Vétérinaire de l'Ontario, où trois inspecteurs vétérinaires fédéraux jugèrent tour à tour si ces carcasses étaient ou non propres à la consommation. On effectua de plus un examen macroscopique détaillé, sur chacune de ces carcasses.

La valeur globale de prédiction du test positif précité atteignit environ 70%. On détermina aussi le degré de concordance du verdict des trois inspecteurs vétérinaires. La concordance globale s'avéra bonne, puisque la valeur Kappa entre le premier et le deuxième inspecteur, ainsi qu'entre le premier et le troisième, atteignait respectivement 0,62 et 0,51. Toutefois, les carcasses confisquées à l'abattoir pour des conditions spécifiques telles que valgus varus, difformité, mutilation, cellulite et hépatite ne firent pas l'unanimité, au delà de la chance, quant à leur disposition, alors que d'autres carcasses condamnées pour des conditions telles que la cyanose et les ecchymoses traumatiques n'entraînèrent qu'une faible concordance, pour au moins une paire d'inspecteurs. La concordance entre les diagnostics posés à l'abattoir ou à la suite de l'examen macroscopique détaillé se révéla généralement très bonne, puisque la valeur Kappa varia de 0,67 à 0,93, sauf pour certaines conditions,

y compris la cyanose, où elle n'atteignit que 0,39, et l'émaciation, dont aucun cas ne fut diagnostiqué au Collège Vétérinaire de l'Ontario.

INTRODUCTION

In 1981, a study was reported (1) which evaluated a modification made to the sequential method of inspection in poultry. The sequential method is a method of inspection in which the postmortem inspection of birds is divided into two stages. The first stage consists of an external examination of the carcass before evisceration, while the second stage includes an examination of the internal cavity of the carcass followed by palpation and examination of the viscera. The modification made to the latter method consisted of partial external examination before evisceration and then complementary external examination plus internal inspection after evisceration. As part of the evaluation (1) of the new procedure, 8400 carcasses approved for human consumption were reexamined and 0.1% were found to be unfit. Among 660 carcasses held for veterinary inspection, approximately 2% revealed no visible lesions. The study dealt with passed and withheld birds, not with condemned birds. The present study was designed to complement the earlier study by examining condemned birds.

Meat inspection can be viewed as a "screening test". In the case of the modified sequential method, the main purpose is the detection of carcasses unfit for human consumption. As with any screening test, errors may be made in the classification of carcasses in the form of false positives and negatives. With appropriate tools, it is possible to determine the distribution of these errors in the population of condemned and passed birds. Sensitivity, specificity and predictive value are measures that reflect these distributions (2,3). Table I illustrates the concept of meat inspection viewed as a screening test and the related measures of evaluation.

The modified sequential method of inspection was studied using the above measures of evaluation. Due to the constraints of this project, only condemned carcasses were sampled.

TABLE I. Meat Inspection of Poultry Viewed as a "Screening Test"

Test Results		Carcass Unfit for Human Consumption[a] (U+)		Carcass Fit for Human Consumption[a] (U−)		
Condemned carcass	(T+)	True pos.	(A)	False pos.	(B)	n1+[b]
Passed carcass	(T−)	False neg.	(C)	True neg.	(D)	n2+[c]
		n + 1		n + 2		n++[d]

[a] as ruled by federal regulations (4,5)
[b] n1+ is the total number of carcasses condemned
[c] n2+ is the total number of passed carcasses
[d] n++ is the total number of birds slaughtered

The rate of condemnation is n1+/n++ (apparent prevalence)
The sensitivity is A/n+1 or p(T+/U+)
The specificity is D/n+2 or p(T−/U−)
The predictive value of a positive test is A/n1+ or p(U+/T+)
The true rate of unfit carcasses is n+1/n++

The objectives of this study were: 1) To determine the relative predictive value of a positive test [PV(T+)], that is the proportion of carcasses truly unfit for human consumption among condemned carcasses. 2) To assess the degree of agreement between conditions diagnosed at the abattoir which lead to the condemnation of carcasses, and a detailed gross postmortem examination of these birds at the Ontario Veterinary College (OVC).

MATERIALS AND METHODS

SAMPLING METHOD

The unit of concern for this study was the individual condemned broiler chicken carcass slaughtered in one federally-inspected poultry abattoir. This plant used a modified sequential inspection method with a separate mobile line on which carcasses requiring veterinary examination were placed. The sampling frame was broilers slaughtered at this abattoir during a two month period (May-June 1986). It was determined that a sample size of a minimum of 500 birds was necessary based on an estimate of the expected PV(T+) being 0.95. A two-stage convenience sampling technique was used with 15 lots of birds as the primary sampling units, and as secondary sampling units, the first 45 condemned carcasses within a lot. One lot, preferably the second lot in the morning, was sampled during each of the 15 days selected.

PROCEDURE USED AT THE ABATTOIR

The first 45 birds condemned by the veterinary inspector within a lot were identified with a wing tag and the reason for condemnation recorded. The diagnoses made by the veterinary inspector were recorded on a form using a coding system that matched the list of conditions used at the abattoir. The sampling of a lot was discontinued as soon as all the condemned carcasses, or the first 45 condemned within a lot, were obtained. Carcasses were transported to the OVC on ice and stored. The individual conducting the detailed postmortem examination at OVC remained blind to the abattoir diagnoses.

The processor was asked to regularly put birds that were preselected on the mobile veterinary line in order to get a representative sampling of these carcasses. Preselected birds are those recognized by plant employees as being potentially unfit for human consumption and that they remove from the normal line, prior to evisceration, for a follow-up veterinary inspection.

For every lot sampled, the following information was also obtained: the sequence of the selected lot within a day at the abattoir, the lot number, the name of the veterinary inspector in charge of the mobile line, the grower's name and address, the total number of birds slaughtered (excluding birds found dead on arrival at the plant) and the total number of birds condemned.

PROCEDURES USED AT OVC

The procedures followed at OVC were divided into two parts. In Part I, a determination of fitness for human consumption was carried out on the

morning following the sampling and was aimed at determining the PV(T+) (as per objective 1). Part II was undertaken during the afternoon and completed, if necessary, the following day. It consisted of a detailed postmortem examination on every sampled carcass and was directed at objective 2.

Part I — The Determination of Fitness for Human Consumption — A federal veterinarian (examiner 1) with more than 25 years experience in poultry inspection served as a "Gold standard" (the best test or evaluation that one can have to determine the "state-of-nature" of a disease or a condition of interest). His task was to determine "the true state-of-nature" regarding the fitness for human consumption of every carcass sampled. This decision was based on his interpretation of the Meat Inspection Act and Regulations (4) and the Meat Hygiene Manual of Procedures (5). Examiner 1 was asked to ignore contamination as a criterion for fitness and was allowed to eviscerate any unopened bird. His judgment, regarding fitness for human consumption was recorded along with the tag number for each bird examined.

Two other veterinarians, also experienced in poultry inspection (examiners 2 and 3) assessed the same birds. All three individuals were blind to the others' judgments. Examiner 1 conducted the first examination followed by the other two. Their findings were initially recorded on separate forms and later collated.

Results from study lot 2 were excluded from the analysis of agreement among examiners, since these cases were discussed after examiner 1 made his judgment and therefore examiner 2 and 3 were not blind to his assessment.

*Part II — Postmortem Examination at OVC — * Prior to the beginning of the study, common poultry conditions usually encountered at abattoirs were defined. A summary of these definitions is shown in Table II (6).

The postmortem examination comprised an external and internal examination. The external examination was performed by looking at the outside of the carcass and included

TABLE II. Summary of the Definition of Conditions Reported

Condition[a][b]	Definitions
Arthritis	As seen in femorotibial +/-[c] tibiometatarsal articulation
Ascites	As seen +/-: (mild or severe lesions of hypertrophy of the right ventricular wall and dilatation of the right ventricle) +/- edema of the liver capsule
	Congestive heart failure would be a more appropriate term
A.S.C.C.	Avian squamous cell carcinoma: as seen
Bruises	As seen
Cellulitis	As seen, generally in the perineal region includes scabby hip and abscess cases
C.R.D.	Chronic respiratory disease
	Airsacculitis +/- pericarditis and epicarditis +/- peritonitis
	P.A.P. (pericarditis-airsacculitis-peritonitis) would be a more appropriate term
Contamination	Not a criteria used for the postmortem at OVC
Cyanosis	Dark coloration of the muscle of the breast without any other primary lesions
Dermatitis	As seen, includes also cases of folliculitis
Emaciation	As seen without any other primary lesions
Emphysema	As seen
Hepatitis	Enlarged liver +/- necrotic foci
Imperfect BL[d]	Skin congestion and focal congestion of the liver without cyanosis +/- bleeding cut
Loss of identity	Absence of one or more organs
Marek's dis	Typical tumoral lesion in: (nerves +/- muscles +/- viscera) and dermatitis-folliculitis
Mutilation	As seen
Neoplasm	Tumors other than Marek's
Overscald	As seen
Pend.Crop[e]	As seen
Peritonitis	As seen without any other primary lesions
Salpingitis	As seen
Septicemia	Not a possible diagnosis based on gross lesions
Synovitis	As seen, tenosynovitis or rupture of tendon is a more appropriate term to describe this condition
V.V.D.	Valgus varus deformity
	A mediolateral deviation of the tibiometatarsal of one or both articulations

[a]Recorded as: 1. Slight   2. Mild   3. Severe
[b]Defined in *Meat Hygiene Manual of Procedures*(5) or *Diseases of Poultry*(6)
[c]Means: and/or or with/without
[d]Imperfect bleeding
[e]Pendulous crop

recording whether or not the bird had been eviscerated and, if so, whether or not it had been eviscerated by the veterinary inspector at the abattoir. During the external examination specific lesions or conditions were recorded and categorized. The internal examination was performed using the following routine. First, the skin of the breast was removed and an incision was made into the underlying muscle. The femorotibial articulations were opened medially and the coloration of the musculature of the thigh was compared to that of the breast. The skin of the perineum was dissected and the abdominal cavity opened. An examination of the air sacs was performed before removing the sternum. The heart was examined and a transverse section was made to identify any signs of dilatation of the right ventricle or hypertrophy of the right ventricular wall. An examination

of the lungs, the pleura and the thoracic cavity followed. Finally, the liver, spleen and intestines were inspected. Only grossly obvious lesions were recorded. Contamination (feces or bile) was not a condition considered because it was impossible to avoid cross-contamination when sampling the carcasses. Birds missing one or more internal organs were also excluded from this part of the study in order to record all potential conditions affecting the viscera (e.g. hepatitis). During the internal examination, specific lesions or conditions were recorded and categorized.

After both the external and internal examinations were complete, recorded conditions were transcribed to the form previously used to record diagnoses at the abattoir. A hierarchy of diagnoses was used and was subjectively based on the severity of the lesions or conditions encountered.

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Diagnoses made at OVC for the first two study lots were excluded from the analysis as they were considered a pilot exercise to verify procedures.

DATA ANALYSIS

All data gathered from the slaughterhouse and from the procedures at OVC were entered into a microcomputer database (dBase III, Ashton-Tate Inc). Each record was verified by comparing the stored data with the original.

The unit of concern and unit of analysis was the individual condemned carcass. The standard error for a cluster sample of unequal size (7) was calculated for every PV(T+) determined. An equation giving an approximation of the variance was used (7). Pooled and paired t-tests (8) were used to evaluate the differences between various predictive values. The Kappa statistic (9) was used to measure the degree of agreement between examiners at OVC and the agreement between the diagnosis made at the abattoir and the postmortem examination done at OVC. P-values were determined to assess the statistical significance of Kappa (10). Fisher's exact test was performed in the case of a small sample size (10).

Calculations for the determination of predictive values, Kappa, their standard errors and Student's t-tests, were done using a spreadsheet software program (SuperCalc 3, Sorcim/IUS) while the p-values associated with the Fisher's exact test were determined by using a customized computer program.

RESULTS

DESCRIPTION OF STUDY LOTS

Table III presents some descriptive data about each lot of birds. Fifteen lots of broilers were sampled resulting in a total of 680 condemned carcasses. These lots were from every day of the week, generally from early in the morning, however, there was a clustering of lots on Tuesday, Wednesday and Thursday. A total of six veterinary inspectors worked on the mobile line during the project. Approximately 60% of the birds were found to be noneviscerated (birds preselected by the processor or by the

TABLE III. Selected Data from Each Lot of Birds Sampled

Study Lot	Abattoir			Carcasses Sampled		
	Sequence[a]	Vet[b]	Total Condemned	Sample Size	Noncontaminated	Noneviscerated
1	8	1	38	38	30	—
2	2	5	90	51	50	—
3	2	2	47	47	45	9
4	2	3	66	45	42	37
5	2	1	80	45	41	31
6	2	1	46	44	43	26
7	3	4	46	46	44	22
8	2	5	118	46	45	25
9	2	5	108	46	46	16
10	2	4	64	46	44	34
11	2	5	134	45	44	26
12	2	4,6	59	45	41	28
13	3	4,6	120	46	45	32
14	3	4,6	87	45	43	41
15	4	5	78	45	44	24
Total			1181	680	647	351

[a]Sequence of the lot sampled within a day
[b]A total of six veterinary inspectors participated in the project

inspectors stationed prior to evisceration). This result reflects only the proportion of noneviscerated birds in the sample, not in the population.

Table IV summarizes the conditions encountered in the carcasses sampled, as well as the rates of condemnation for specific conditions diagnosed during the months of May and July 1986 at the abattoir as a whole. It can be seen that some conditions, e.g. synovitis, avian squamous cell carcinoma (ASCC), salpingitis, dermatitis, paralytic ileus, emphysema, Marek's disease, overscald, peritonitis, anemia, ovarian tumor, neoplasm, arthritis, loss of identiity and septicemia, offer few if any possibilities for comparison because of their small number. No diagnoses of emaciation were made at OVC. In 107 cases, no visible lesions (NVL) were observed during postmortem examination at OVC. Another difference to note is the rate of carcasses diagnosed to be cyanotic. At the abattoir, cyanosis accounted for 19.26% of the diagnoses compared to 8.24% at OVC. A similar situation existed for CRD (1.03% vs 2.35%), synovitis (1.03% vs 0.29%) and pendulous crop (0.88% vs 3.24%).

RELATIVE PREDICTIVE VALUE OF A POSITIVE TEST [PV(T+)]

Table V shows selected PV(T+) determined from the three examiners' assessments.

For examiner 1 (the "Gold standard") a PV(T+) of 69.1%, with a 95% confidence interval of 62.4% to 75.8% was obtained. The PV(T+) for eviscerated and noneviscerated birds is also shown (Table V). Using pooled t-tests, no statistical differences between eviscerated and noneviscerated or between the latter and the overall PV(T+) were detected. The PV(T+) for specific conditions diagnosed at the abattoir and OVC are also presented. All such conditions were compared to the overall PV(T+) using the t-test. Conditions such as imperfect bleeding, VVD, cyanosis and NVL as diagnosed at OVC, differed significantly from the overall PV(T+). The PV(T+) for birds inspected by the different veterinary inspectors are also shown. There were no statistically significant differences between the inspectors, as well as no deviation from the overall PV(T+).

With respect to examiners 2 and 3, the PV(T+) obtained were generally similar to the ones obtained by examiner 1. Using paired t-tests for correlated means, statistical differences between the overall PV(T+) for examiners 2 and 3 were investigated. As with examiner 1, imperfect bleeding, NVL and cyanosis (OVC) showed a statistically significant difference from the overall PV(T+). Ascites, mutilation, cyanosis (abattoir) and cellulitis were statistically different

TABLE IV. Comparison of Diagnoses Made at the Abattoir and OVC

| Condition | Abattoir | | | Ontario Veterinary College Condition | | | |
| | Sample | | May[a] June 1986 | Primary[b] | | Secondary | Tertiary |
	# of cases	%	%	# of cases	%	# of cases	# of cases
Cyanosis	131	19.26	18.5	56	8.24	8	1
Bruising	126	18.53	21.9	113	16.62	11	3
Emaciation	89	13.09	16.5	0	0.00		
Mutilation	74	10.88	7.2	76	11.18	13	
Cellulitis	48	7.06	1.1	54	7.94	6	3
Ascites	47	6.91	4.9	33	4.85	1	
Imperfect bleeding	34	5.00	3.2	24	3.53	1	
Contamination	33	4.85	7.8	not considered			
Valgus varus deformity (V.V.D.)	30	4.41	11.5	21	3.09	3	
Hepatitis	22	3.24	1.6	27	3.96	13	2
Chronic respiratory disease (C.R.D.)	7	1.03	0.9	16	2.35	7	3
Synovitis	7	1.03	0.7	2	0.29		
Avian squamous cell carcinoma (A.S.C.C.)	6	0.88	0.3	8	1.18		
Pendulous crop	6	0.88	0.6	22	3.24	24	4
Salpingitis	4	0.59	0.1	4	0.59		
Dermatitis	3	0.44	1.2	5	0.74	21	3
Paralytic ileus	2	0.29	0.0	2	0.29		
Emphysema	1	0.15	0.0	0	0.00		
Marek's disease	1	0.15	1.2	0	0.00		
Overscald	1	0.15	1.5	0	0.00		
Peritonitis	1	0.15	0.0	1	0.15		
Anemia	1	0.15	0.0	0	0.00		
Ovarian tumor	1	0.15	0.0	0	0.00		
Neoplasm	0	0.00	0.0	1	0.15		
Arthritis	0	0.00	0.0	2	0.29	2	1
Loss of identity	0	0.00	0.0	0	0.00		
Septicemia	0	0.00	0.0	0	0.00		
No visible lesion (N.V.L.)	0	0.00	—	107	15.74		
Transcription errors	5	0.88	—	2	0.29		
Excluded[c]	0	0.00	—	89	13.09		
No viscera	0	0.00	—	14	2.06		
Total	680			680		116	21

[a] Proportion of condemnations for the plant for specific conditions from a total of 99,262 carcasses condemned during this period
[b] Each of the listed conditions seen during the postmortem examinations at OVC was recorded and classified as primary, secondary or tertiary
[c] Diagnoses at OVC for the first two lots were excluded

from the overall PV(T+) for one or both examiners.

There was some variation in PV(T+) from lot to lot. For example, and for examiner 1, it ranged from 0.50 to 0.93.

AGREEMENT BETWEEN EXAMINERS

Table VI shows Kappa statistics for various combinations of examiners. The overall agreement between examiner 1 and 2 was found to be 0.62 (95% CI of 0.51, 0.73) and between examiner 1 and 3, Kappa was 0.51 (0.42, 0.59). As can be seen, there was a trend toward higher agreement when assessing noneviscerated birds for both pairs of examiners. The level of agreement was examined for every condition as diagnosed at the abattoir. For examiners 1 and 2, there was no agreement beyond chance for cellulitis and hepatitis. For examiners 1 and 3, VVD and mutilation were the discordant conditions.

LEVEL OF AGREEMENT BETWEEN ABATTOIR AND OVC DIAGNOSES

There was good agreement between diagnoses made at the abattoir and OVC for most of the conditions reported (Table VII). The agreement was excellent for conditions such as imperfect bleeding (Kappa = 0.93), bruising (Kappa = 0.91) and cellulitis (Kappa = 0.86). The agreement was very good for mutilation (Kappa = 0.76) and VVD (Kappa = 0.71). The agreement was good for hepatitis (Kappa = 0.68) and ascites (Kp = 0.67). The agreement was poor for cyanosis (Kappa = 0.39), CRD (Kappa = 0.34), pendulous crop (Kappa = 0.29) and nonexistent for emanciation. Whether a bird was eviscerated did not generally influence the degree of agreement.

DISCUSSION

Estimating the predictive value is simply determining the proportion of carcasses that are truly unfit for human consumption in the target population of all carcasses condemned. In order to estimate a true PV(T+) a random sampling of condemned carcasses was necessary. A two-stage convenience sample of lots of birds was the only practical way to obtain condemned carcasses. Carcasses were sampled whenever it was convenient for the inspection staff and for the examiners at OVC. Despite these limitations, it is felt that a representative sample of lots of birds was obtained for this study.

Another potential bias arose from the fact that only the first 45 condemned carcasses were selected. The greatest concern was with respect to sampling preselected carcasses in order to obtain a representative sample of both eviscerated and noneviscerated carcasses. At the abattoir, preselected birds were normally put on the veterinary inspection line at the end of the lot, thus creating a bias. However, two facts minimized this bias: the processor was asked to put the preselected carcasses regularly on the veterinary inspection line (nevertheless there was no control over this) and in many lots a very large sampling fraction was obtained (see Table II for study lots 1,3,4,6,7,10 and 12). Because of this, it is felt that a representative sample of condemned carcasses within lots was obtained.

In Table IV, the overall proportions of condemnations for specific condi-

TABLE V. Selected[a] Relative Predictive Values of a Positive Test [PV(T+)] Calculated for Each of the Three Examiners[bc]

	"Gold Standard" Examiner 1		Examiner 2		Examiner 3	
	PV(T+)	SEM	PV(T+)	SEM	PV(T+)	SEM
Overall	0.691	0.034	0.636	0.024	0.671	0.027
For:						
Noneviscerated birds	0.668	0.035	0.613	0.028	0.657	0.040
Eviscerated birds	0.689	0.047	0.678	0.057	0.717	0.036
For Specific Conditions Diagnosed at:						
Abbatoir						
Imperf.bl.	1.000***[d]	0.000	1.000***	0.000	1.000***	0.000
Ascites	0.864	0.041	0.906***	0.030	0.872***	0.041
Mutilation	0.803	0.076	0.778*	0.073	0.838*	0.059
Bruising	0.721	0.038	0.697	0.058	0.675	0.058
Emaciation	0.667	0.045	0.609	0.092	0.685	0.069
Hepatitis	0.579	0.126	0.765	0.158	0.636	0.106
Cyanosis	0.555	0.076	0.450**	0.061	0.620	0.055
V.V.D.	0.520*	0.085	0.520	0.089	0.679	0.092
Cellulitis	0.514	0.127	0.444	0.130	0.313***	0.100
OVC						
Cyanosis	0.800*	0.051	0.852***	0.060	0.927***	0.032
N.V.L.	0.452**	0.081	0.353***	0.090	0.484*	0.087
For Birds Inspected by:						
Vet. Insp. #1	0.845	0.087	—[e]	—	0.734	0.098
Vet. Insp. #6	0.701	0.054	0.672	0.044	0.661	0.081
Vet. Insp. #4	0.655	0.048	0.619	0.041	0.631	0.051
Vet. Insp. #5	0.640	0.060	0.579	0.080	0.685	0.034

[a]All diagnoses with at least ten cases from the abattoir
[b]Contaminated birds were excluded from the determination of the PV(T+)
[c]The panel of examiners was composed of three veterinarians with different levels of experience in poultry inspection. Examiner 1 was the one with the most experience
[d]T-tests for noncorrelated means were done to compare the PV(T+) of specific conditions to the overall PV(T+): *, $p \leq 0.05$; **, $p \leq 0.01$; ***, $p \leq 0.001$
[e]Not examined

tions are shown for May-June 1986 (sampling frame). No major discrepancies were found between the rates obtained in the present study and the condemnation rates in all birds slaughtered during the same time frame. Sampling variation explains the larger proportion of birds with cellulitis and the lower proportion of birds with VVD in the present study.

With respect to the procedure used at the slaughterhouse (the execution of the sampling itself and the recording of the diagnoses made on every condemned carcass) a possible bias may have arisen due to the fact that the veterinary inspectors were aware of the study. The extent to which their activities differed from normal as a result of the study cannot be determined.

In part I of the procedure used at OVC a "relative" predictive value was estimated. In theory, "Gold standard"

determination should be of a different nature than the test being evaluated (2,3,9). This was not the case here. Examinations at the abattoir and OVC were based on gross lesion criteria. Nonetheless, the nature of the "Gold standard" examination was reasonable considering the known expertise of examiner 1 in poultry inspection and the conditions under which he worked compared to those in the abattoir. He had the necessary facilities and time to conduct his examination, which is not usually the case for a veterinary inspector in an abattoir.

Another important potential bias in this study relates to the fact that examinations were made on condemned birds only, and the examiners were not blind to this fact. The potential effect of this will be discussed later.

In part II of the procedures used at OVC, cases of cyanosis presented

difficulties because of the subjective nature of the evaluation of this condition. Many times it was impossible to determine the degree of severity of cases or to differentiate between a congested breast and a cyanotic one. The criterion used with most confidence was to compare the brown musculature of the leg to the white musculature of the breast. In obvious cases of cyanosis, the color of the musculature at both sites was similar. The characterization of this condition needs to be refined.

As shown in Table V, and bearing in mind the above mentioned biases in the evaluation of the PV(T+), a value close to 70% represents a good achievement. The effect of these biases on the PV(T+) would be to overestimate the actual PV since the PV(T+) tends to be higher in a group of animals tested where the prevalence of the condition of interest is high (8). This was the situation in the present study where the probability of selecting birds that are unfit for human consumption was obviously higher when sampling condemned carcasses only, than what one would expect when selecting from all carcasses.

With respect to specific conditions the high PV(T+) for imperfect bleeding, mutilation and ascites (Table V) is understandable because these conditions, when present, were easily detectable and generally severe. Carcasses condemned for VVD and cellulitis at the abattoir had a tendency to have a lower PV(T+). For examiners 1 and 3, these lower values were statistically significant. The reason for these low PV(T+) was thought to be the fact that all the birds with cellulitis, and most cases of VVD, were routinely condemned at the abattoir. At OVC, these birds were judged fit for human consumption whenever the lesions were trimmable.

Another interesting finding was the fact that birds classified at OVC as having no visible lesions (107 cases) had a significantly lower PV(T+). Forty-four percent of these cases were condemned for emaciation and 39% for cyanosis at the abattoir. This raises the question whether certain birds condemned for emaciation or cyanosis should in fact be condemned.

It is interesting to note that cases diagnosed as cyanotic at the abattoir

TABLE VI. Agreement among Examiners in Assessing Fitness for Human Consumption (using Kappa)

Conditon[a]	Examiners 1 and 2		Examiners 1 and 3	
	Kappa	p-value	Kappa	p-value
Overall	0.62	< 0.001	0.51	< 0.001
Noneviscerated	0.70	< 0.001	0.59	< 0.001
Eviscerated	0.51	< 0.001	0.38	< 0.001
V.V.D.	0.78	0.004[b]	0.23	0.445
Emaciation	0.65	0.002	0.55	< 0.001
Mutilation	0.65	0.004	0.32	0.062
Ascites	0.63	0.000	0.62	0.011
Bruising	0.62	< 0.001	0.48	< 0.001
Cellulitis	0.57	0.103	0.43	< 0.025
Cyanosis	0.45	< 0.005	0.52	< 0.001
Hepatitis	0.39	0.350	0.67	0.013
Imperfect bleeding[c]				

[a] Ten cases or more diagnosed at the abattoir
[b] P-values calculated using Fisher's exact test
[c] All cases seen were judged unfit for human consumption

had a lower PV(T+) than cases of cyanosis diagnosed at OVC. This is probably a reflection of having no passed birds mixed with condemned birds at OVC, and hence the condition was more difficult to detect. Therefore, when a bird was identified as cyanotic at OVC it was probably an obvious case with an obvious disposition and consequently a significantly higher PV(T+).

In Table V, significant differences observed between the overall and specific PV(T+) would have been more pronounced if instead of using the overall PV(T+), a comparison had been made with an overall PV(T+) excluding the condition specifically being compared (as used there is a partial correlation). This was simply a decision to err on the side of caution. The reader is cautioned, however, that because of the large number of independent tests of significance performed, some of the significant differences found could arise due to chance alone.

The variability of the estimates between lots was higher than expected. The overestimation of the PV(T+) when determining the sample size contributed to the rather large standard error found. Sampling more lots of birds (not necessarily more birds) would have helped to decrease the variability observed.

The agreement between examiners when determining the PV(T+) was generally good (Table VI) indicated by a Kappa statistic between 0.6 to 0.7 (9). The trend toward a lower agreement

when looking at eviscerated carcasses probably reflects the fact that these birds, having not been preselected for obvious lesions, may have had very mild lesions subject to greater variability in interpretation.

As can be seen in Table VI, disagreement existed for certain specific conditions, namely VVD, mutilation, cellulitis and hepatitis. This is at least partly due to the vagueness of the criteria used to define the fitness of these carcasses. All these conditions are subject to interpretation and the importance assigned to certain lesions may vary from one individual to another. Also, the limited sample size for cellulitis and hepatitis may have played a role in the lack of agreement.

There was perfect agreement about the fitness of the 38 cases of imperfect bleeding even though Kappa was not significant. All were judged unfit for human consumption without exception by the three examiners. A test of agreement was therefore inappropriate considering that only one status was determined for these birds.

In general the agreement between the diagnoses made at the abattoir and those made at OVC were good except for four conditions, namely cyanosis, CRD, pendulous crop and emaciation (see Table VII). Also as previously presented (Table IV), 107 carcasses were diagnosed as having no visible lesion at OVC.

In the case of carcasses diagnosed as cyanotic at the abattoir, the PV(T+) as determined by examiner 1 was 0.56 (0.45 and 0.62 for examiners 2 and 3 respectively). The criteria used to diagnose this condition need to be refined and its disposition (fit or unfit) reassessed considering the low agreement with the diagnoses at OVC and the trend toward a lower predictive value.

For CRD the lower Kappa could be due to the fact that of the 16 cases seen at OVC, seven were diagnosed in noneviscerated or preselected carcasses. For pendulous crop the discrepancy was probably because in many cases this condition was mild and not considered sufficient for condemnation at the abattoir. These carcasses were condemned for other reasons.

The term emaciation is generally misused in poultry inspection. The definition used in the present study

TABLE VII. Agreement (Kappa;Kp) Between Selected[a] Diagnoses Made at the Abattoir and Diagnoses made at OVC

Condition	Overall		Non-eviscerated		Eviscerated	
	Kp	p-value	Kp	p-value	Kp	p-value
Imperf. bleed.	0.93	0.000[b]	0.95	0.000	0.80	0.000
Bruising	0.91	< 0.001	0.94	< 0.001	0.70	0.000
Cellulitis	0.86	0.000	0.87	0.000	0.83	0.000
Mutilation	0.76	< 0.001	0.66	0.000	0.75	< 0.001
V.V.D.	0.71	0.000	0.75	0.000	0.61	0.000
Hepatitis	0.68	0.000	0.66	0.000	0.69	0.000
Ascites	0.67	0.000	0.61	0.000	0.71	0.000
Cyanosis	0.39	< 0.001	0.49	< 0.001	0.22	< 0.001
C.R.D.	0.34	0.000	—	—	0.48	0.000
Pend. crop	0.29	0.000	0.37	0.000	-0.01	1.000
Emaciation[c]						

[a] At least ten cases from the abattoir or OVC
[b] P-values calculated using Fisher's exact test
[c] No diagnoses of emaciation were made at OVC

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comes from the Meat Hygiene Directive 1984-23 (5) which describes carcasses as exhibiting a state of extreme leanness. No bird with such a lesion as a primary condition was diagnosed at OVC. The cases that were encountered were considered secondary to other primary conditions such as ascites, VVD, hepatitis, CRD, and severe cases of pendulous crop. The birds condemned for emaciation at the abattoir were in many cases small birds preselected by the processor because of their small size and other minor defects. There is presently no appropriate terminology to describe these birds or criteria to determine their final disposition within federal regulations.

As mentioned earlier, of the 107 cases diagnosed as having NVL at OVC, 43.9% were condemned at the abattoir for emaciation, 39.3% for cyanosis, 9.3% for contamination and 7.5% for other conditions. These numbers illustrate that criteria for condemning for emaciation and cyanosis need to be reexamined. A new term to describe small birds which are unfit for human consumption is required.

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