Original Article
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Reuse of disposable laparoscopic instruments: cost analysis*

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Objective: To evaluate the cost benefits of reusing disposable laparoscopic instruments.

Design: A cost-analysis study based on a review of laparoscopic and thoracoscopic procedures performed between August 1990 and January 1994, including analysis of disposable instrument use, purchase records, and reprocessing costs for each instrument.

Setting: The general surgery department of a 461-bed teaching hospital where disposable laparoscopic instruments are routinely reused according to internally validated reprocessing protocols.

Methods: Laparoscopic and thoracoscopic interventions performed between August 1990 and January 1994 for which the number and types of disposable laparoscopic instruments were standardized.

Main Outcome Measures: Reprocessing cost per instrument, the savings realized by reusing disposable laparoscopic instruments and the cost-efficient number of reuses per instrument.

Results: The cost of reprocessing instruments varied from $2.64 (Can) to $4.66 for each disposable laparoscopic instrument. Purchases of 10 commonly reused disposable laparoscopic instruments totalled $183 279, and the total reprocessing cost was estimated at $35 665 for the study period. Not reusing disposable instruments would have cost $527 575 in instrument purchases for the same period. Disposable laparoscopic instruments were reused 1.7 to 68 times each.

Conclusions: Under carefully monitored conditions and strict guidelines, reuse of disposable laparoscopic and thoracoscopic instruments can be cost-effective.

Objectif : Évaluer la rentabilité de la réutilisation d'instruments de laparoscopie jetables.

Conception : Étude d'analyse des coûts fondée un examen des interventions effectuées par laparoscopie et thoracoscopie entre août 1990 et janvier 1994, y compris analyse de l'utilisation d'instruments jetables, des dossiers d'achat et des coûts de retraitement de chaque instrument.

Contexte : Le service de chirurgie générale d'un hôpital d'enseignement de 461 lits où l'on réutilise régulièrement des instruments de laparoscopie jetables conformément à des protocoles de retraitement validés à l'interne.

Méthodes : Interventions par laparoscopie et thoracoscopie effectuées entre août 1990 et janvier 1994, dont on a normalisé le nombre et le type d'instruments de laparoscopie jetables.

Principales mesures des résultats : Coût de retraitement par instrument, économies réalisées en réutilisant des instruments jetables et nombre de réutilisations rentables par instrument.

Résultats : Le coût de retraitement des instruments varie de 2,64 $ à 4,66 $ CAN par instrument de laparoscopie jetable. Les achats de dix instruments de laparoscopie jetables réutilisés régulièrement ont totalisé 183 279 $ et le coût total de retraitement a été estimé à 35 665 $ au cours de la période d'étude. Si l'on n'avait pas réutilisé d'instruments jetables, il en aurait coûté 527 575 $ en achats d'instruments au cours de la même période. Les instruments de laparoscopie jetables ont été réutilisés de 1,7 à 68 fois chacun.

Conclusions : Dans des conditions surveillées attentivement et conformément à des lignes directrices rigoureuses, la réutilisation d'instruments de laparoscopie et de thoracoscopie jetables pourrait être rentable.

This article is a follow-up to the paper "Reuse of disposable laparoscopic instruments: surgical complications," which appeared in the December 1995 issue, pages 497 to 500

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Until recently, reuse of medical devices was common in many health care institutions. In the early 1970s, hospital administrators turned to disposable instruments in an effort to curb rising labour costs. Because of some reimbursement practices in the United States, disposable instruments also provided a convenient way of accurately billing patients.[1,2]

The recent explosion in laparoscopic instrument technology has perpetuated the popularity of disposable instruments.[3] Rapid changes in instrument design favoured instruments that could be quickly assembled and marketed. The issue of disposable instruments was also difficult to avoid in laparoscopic surgery because some (e.g., the linear stapler and the multiple clip applier) were available only in this form and others (e.g., working port trocars and scissors) offered superior characteristics. Disposable instruments therefore occupied a large share of the laparoscopic instrument market but not without some concern about their cost.[4–7]

When laparoscopic surgery was introduced at the Hôpital du Saint-Sacrement in August 1990, staff and administrators adopted a policy of reusing disposable laparoscopic instruments. All procedures were performed with the most appropriate mixture of reused disposable and reusable instruments, giving surgeons access to a broad range of instruments. Therefore, costly disposable items, such as the mechanical linear stapler, were available when required. Other instruments were selected for their functional characteristics, and if a disposable instrument was considered superior, it was acquired. Furthermore, disposable instruments that could be reprocessed effectively and safely were selected over other disposable instruments. Instruments continue to be evaluated, selected and purchased on the basis of their design qualities, cost and ability to be reprocessed.

Before being reprocessed, each new type of disposable instrument was submitted to microbacteriologic testing, a reprocessing protocol was developed, the staff received appropriate training and an ongoing quality control process was established. Disposable laparoscopic instruments were released for reuse only after these requirements were fulfilled. For example, our tests revealed that trocars of laparoscopic ports could not be adequately cleaned before sterilization, so they were never reprocessed.

The goal of this study was to present a cost analysis of the reuse of disposable laparoscopic instruments. All monetary references are expressed in Canadian dollars.

Methods

The cost analysis was based on disposable laparoscopic instrument uses and instrument purchases for laparoscopic and thoracoscopic procedures performed between August 1990 and January 1994 by the general surgery department. The total number of procedures was obtained from prospective data sheets and a search of hospital records. The number and types of disposable laparoscopic instruments used for each of the different procedures performed was standardized; from this, it was possible to calculate the number of times a certain type of instrument had been used. Adjustments were made to account for the use of a limited number of instruments by the Department of Orthopedics and the Department of Obstetrics and Gynecology, based on the number of cases in which these instruments were used during the study period.

Operating-room purchase records from August 1990 to December 1993 were used to obtain the number of disposable laparoscopic instruments acquired. The average number of uses per instrument could then be calculated from the number of procedures, the number of disposable instruments used in each procedure and the number of instruments bought.

The reprocessing cost was defined as the sum of the cost of materials, labour and training personnel. The cost of labour was calculated by measuring the time it takes an employee to reprocess a single instrument. The cost of training was assessed on the basis of a 2-hour one-on-one session per instrument type per employee. The central processing department has 23 employees. This cost was then amortized over the total number of reprocessings for that instrument. An hourly wage of $15.88, which includes all social benefits, was used to estimate the cost of reprocessing and training. Purchase of new cleaning and sterilizing equipment was also considered. A reprocessing cost was thus calculated for each instrument. The number of reprocessings was calculated by subtracting the number of items purchased from the total number of uses, since no reprocessing is associated with the first use of the instrument. This information was then used to estimate the overall savings realized by reuse compared with the cost of a strict no-reuse policy for disposable instruments for the same number of procedures.

Finally, a model was created to estimate the running cost for any individual instrument considered for reuse, based on the number of uses per instrument, the purchase price of the instrument and the estimated reprocessing cost. Alternative scenarios were developed to reflect the possible variations in reprocessing costs from one institution to another.

Table I

Number of Reuses of Disposable Laparoscopic Instruments

Procedure (and no.)	Veress needle	Trocar sleeve	Reducer	Scissors	Dissector	Grasper	Clip applier	Intestinal gauge	Linear stapler	Camera bag	Total
Cholecystectomy (646)	646	1 292	2 584	—	—	—	646	—	—	646	5 814
Colonic resection (61)	61	122	244	61	—	122	61	61	61	61	854
Appendectomy (37)	37	74	74	—	—	—	—	37	37	37	296
Nissen fundoplication (22)	22	66	88	22	22	44	22	—	—	22	308
Splenectomy (14)	14	42	56	14	14	28	14	14	14	14	224
Diagnostic laparoscopy (11)	11	22	22	—	—	—	—	—	—	11	68
Vagotomy (6)	6	18	24	6	6	12	6	—	—	6	84
Retroperitoneal lymphadenectomy (4)	4	8	8	—	—	4	4	—	—	4	32
Lysis of adhesions (5), relief of small-bowel obstruction (1)	6	12	12	6	—	12	—	—	—	8	54
Small-bowel resection (4)	4	8	8	—	—	8	—	—	—	4	32
Gastrectomy (2), cystogastrostomy (1), esophagectomy (4)	7	21	28	7	7	14	7	7	7	7	112
Inguinal hernia repair (1)	1	3	1	1	1	—	—	—	—	1	8
Partial cystectomy (1)	1	3	2	1	1	2	1	—	—	1	12
Diagnostic thoracoscopy (31)	—	—	—	31	—	—	—	31	31	31	124
Esophagomyotomy (8)	—	—	—	8	8	8	—	—	—	8	32
Pleurectomy (7)	—	—	—	7	—	7	—	7	7	7	35
Thoracic sympathectomy (4)	—	—	—	4	4		4	—	—	4	20
Pulmonary lobectomy (4)	—	—	—	4	4	—	4	4	4	4	24
Adjustments for gynecology and orthopedics	—	416	1 560	—	—	—	—	—	208	2 995	5 179
Total (A)	820	2 107	4 711	172	67	265	769	161	369	3 869	13 310
Instruments purchased (B)	12	1 086	360	9	9	12	464	3	63	546	2 564
Reprocessing (A) – (B)	808	1 021	4 351	163	58	253	305	158	306	9 323	10 746
Uses per instrument (A)/(B)	68	2	13	20	7	22	1.7	53	6	7	5

RESULTS

Most disposable laparoscopic instruments are used by the general surgery department only. However, linear mechanical staplers, reducers, 12-mm trocars and camera sheaths are also used during gynecologic and orthopedic procedures. The total number of uses (Table I) has therefore been adjusted to take this into account.

The number of uses per instrument ranged from 1.7 for multiple clip appliers to 68 for Veress needles. As an example, a detailed itemization of materials and labour costs for laparoscopic scissors is shown in Tables II and III. Similar calculations were used to determine the reprocessing cost of each instrument. The total reprocessing cost for each type of instrument ranged from $2.64 to $4.66 (Table IV).

Our investigation revealed no new equipment purchases and no increases in manpower to meet the added demand of reprocessing disposable laparoscopic instruments. Also, the gas sterilizer, which routinely operates three times a day, has not functioned more frequently since the advent of laparoscopic surgery. For this reason, the cost of ethylene oxide and the operating costs of the sterilizer were not taken into account in our assessment.

From the number of uses of each disposable instrument, the cost can be

Table II

Cost Estimate of Materials for Reprocessing Laparoscopic Scissors

Materials required	Cost, $
Enzyme solution (20 g/d for 6 instruments at a cost of $131.20 for 5 kg) Cost of solution/instrument	0.09
Sterile wrap Wrap 1 (22.5 x 55 cm)	0.39
Wrap 2 (22.5 x 62.5 cm)	0.44
Coding label	0.01
Total cost	0.93

Table III

Time and Cost Estimate of Labour for Reprocessing Laparoscopic Scissors

Transport from operating room to central processing, min	0.25
Washing, min Filling and emptying ultrasound cleaner	1.00
Manual cleaning and rinsing of instrument handle	2.00
Rinsing, min Filling container (x 3)	3.00
Compressed air drying	1.00
Transport to dryer	0.50
Inspection, wrapping and sterilization, min	3.00
Inspection and transport to operating room, min	0.50
Total time, min	11.25
Hourly wage, $	15.88
Total cost of labour, $	2.98

Table IV

Total Reprocessing Costs ($) per Instrument

Instrument	Materials	Labour	Training	Total cost
Veress needle	0.39	3.18	0.04	3.61
Trocar sleeve	0.39	3.18	0.03	3.60
Reducer	0.28	3.18	0.01	3.47
Scissors	0.93	3.18	0.19	4.30
Dissector	0.93	3.18	0.55	4.66
Grasper	0.93	3.18	0.13	4.24
Clip applier	1.12	2.98	0.10	4.20
Intestinal gauge	0.93	3.18	0.20	4.31
Linear stapler	0.84	2.98	0.10	3.92
Camera bag	0.52	2.11	0.10	2.64

Table V

Comparison of the Costs ($) of Single Use Versus Reuse of Disposable Laparoscopic Instruments

Instrument (no. of uses)	Single use*	Reuse†
Veress needle (820)	20 500	3 216.88
Trocar sleeve (2 107)	169 551	90 735. 60
Reducer (4 711)	37 680	17 974.50
Scissors (172)	21 672	1 834.90
Dissector (67)	8 442	1 404.28
Grasper (265)	33 390	2 584.72
Clip applier (769)	115 350	70 881.00
Intestinal gauge (161)	1 288	704.98
Linear stapler (369)	92 619	17 012.52
Camera bag (3 869)	27 083	12 594.72
Total	527 575	218 944.10

*The total cost if new disposable instruments were purchased for each use
†The actual purchase cost of instruments for first use plus the cost of reprocessing for each reuse

estimated for single use ($527 575) during the same period, that is, the theoretical cost of using a new instrument each time. The cost with reuse is the sum of the disposable instrument purchase price ($183 279) and all reprocessing expenses ($35 665). The estimated savings resulting from reuse totalled $308 631 (Table V).

Discussion

Because our hospital already performs cleaning and sterilization procedures routinely on several instruments, reuse of disposable laparoscopic instruments represents a proportionately small increase in workload. The total reprocessing costs (materials, labour and training), ranging from $2.64 to $4.66, demonstrate that reprocessing disposable laparoscopic instruments can be inexpensive (Table IV).

It was assumed that there were no new or reprocessed instruments in inventory at the end of the study period. For this reason, purchase data include the initial purchase of disposable equipment up to 1 month before the end of the study, to reduce the potential bias introduced by instruments in storage.

Many aspects of reprocessing are difficult to evaluate, for example, the cost of microbiologic testing, the time and effort spent to coordinate the initial trials and the cost of storing disposable instruments. Also, because of insufficient information on the number of uses and repairs, we could not make a comparison with reusable instruments.

The cost benefits of reuse for individual instruments can be evaluated from the following equation: $TC_{100} = AC(100/x) + R(100 - 100/x)$, where TC_{100} = total cost for 100 uses, AC = acquisition cost of a single instrument, R = reprocessing cost for a single instrument and x = the number of uses per instrument. A plot of this equation provides a representation of expected savings according to the number of uses per instrument. Several scenarios can be created to account for variations in reprocessing cost estimates. The example of the Veress needle (Fig. 1) demonstrates that total cost decreases with lower reprocessing cost and greater number of uses per instrument. This type of curve applies to most reused disposable instruments. The benefits are even greater with a more expensive instrument, such as the disposable laparoscopic scissors (Fig. 2).

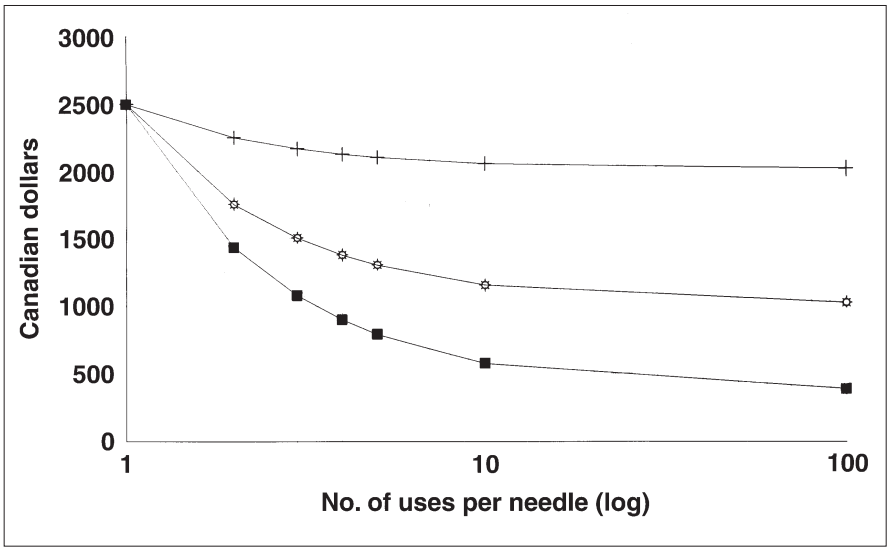

FIG. 1. Cost of 100 uses of Veress needle. Scenarios are presented for reprocessing costs of $20 (Can) (+), $10 (N) and actual reprocessing cost in this study (n) of $3.61. Cost decreases with increasing number of uses per needle and cost of reprocessing. Cost of new disposable Veress needle is $25.

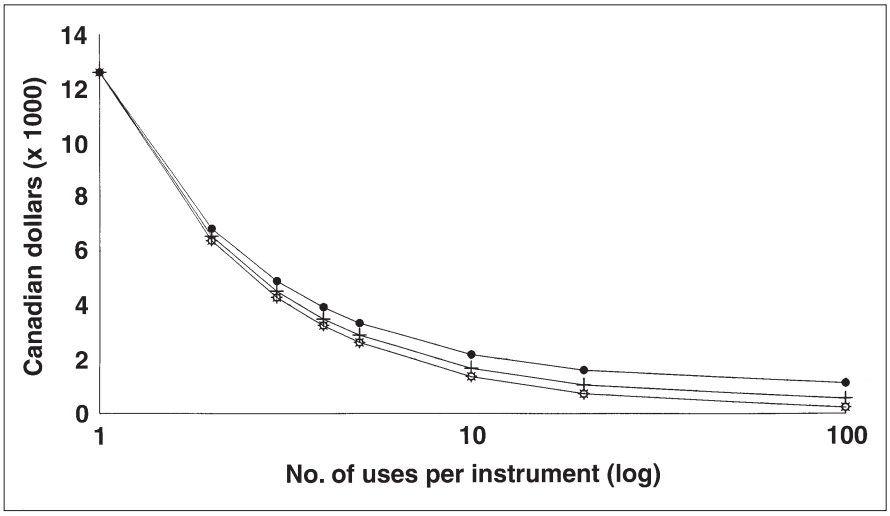

FIG. 2. Cost of 100 uses of disposable laparoscopic scissors. Scenarios are presented for reprocessing costs of $10 (•), $1 (N) and actual reprocessing cost in this study (+) of $4.30. Wide difference between purchase cost and reprocessing cost leads to greater savings and smaller effect of reprocessing-cost fluctuations on overall savings. Cost of new disposable laparoscopic scissors is $126.

Doubling or tripling the reprocessing cost of this instrument would have little impact on overall savings. On the other hand, reuse is not beneficial if the reprocessing cost exceeds the purchase cost, as shown in the example of the plastic camera bag (Fig. 3). The alternative scenario, in which the reprocessing cost is $10 (R = $10) demonstrates that reuse is actually more expensive than single use, since a plastic camera bag costs only $7.25.

In the example of the mechanical linear stapler (Fig. 4), a new cartridge, costing $120.33, must be added with each reuse. Large variations in reprocessing cost have little impact on the total savings because the cost of reuse stems mostly from the new cartridge. This graph also shows that most savings are achieved before 10 uses of the instrument. This information is useful if concerns exist regarding the mechanical integrity of this complex instrument. Beyond a certain point, the risk of mechanical failure outweighs the potential savings, and the instrument should be discarded. It should be noted that, as in open surgery, the surgeon has the responsibility of determining the functional integrity of any surgical instrument before its use.

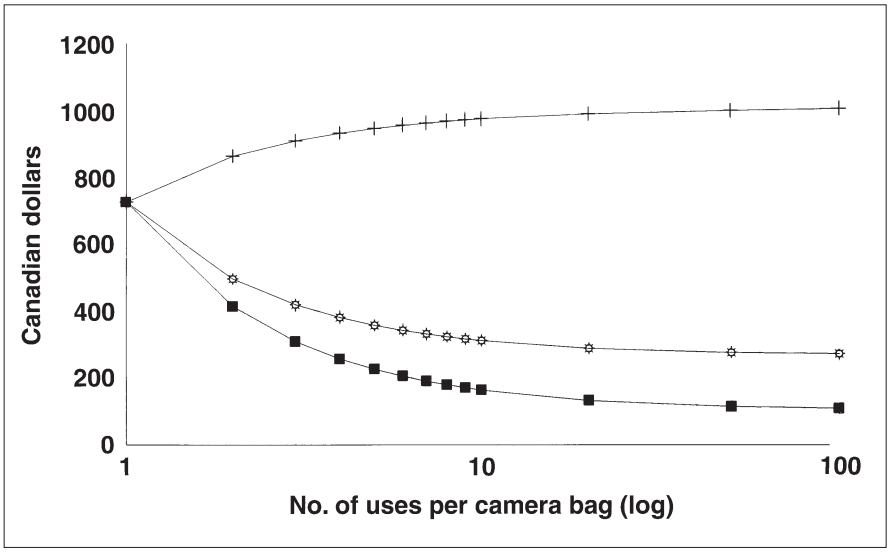

FIG. 3. Cost of 100 uses of plastic camera bag. Scenarios are presented for reprocessing costs of $10 (+), $1(n) and actual reprocessing cost in this study (N) of $2.64. Note scenario where reprocessing cost of $10 exceeds purchase cost of bag, showing no benefit of reuse. Cost of new camera bag is $7.25.

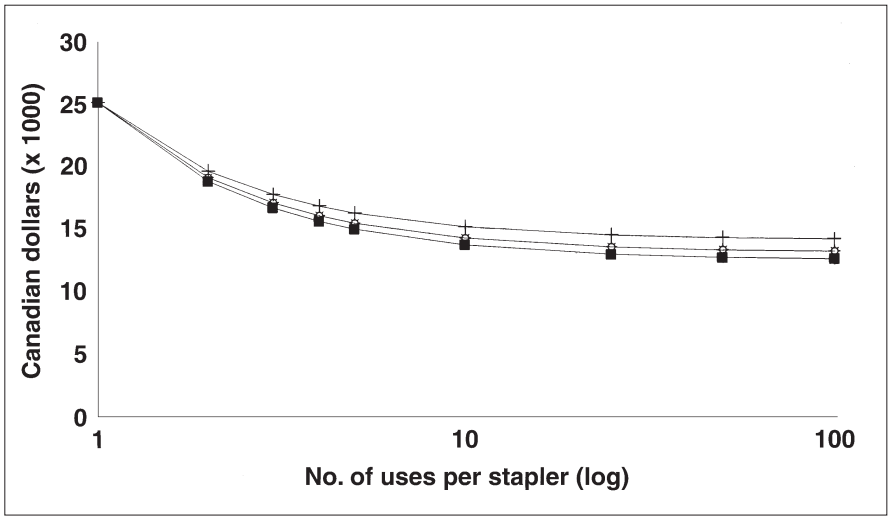

FIG. 4. Cost of 100 uses of linear stapler. Scenarios are presented for reprocessing costs of $20 (+), $10 (N) and actual reprocessing cost in this study (n) of $3.92. Reuse cost reflects mostly cost of new cartridge of staples ($120.33). Potential savings are minimal beyond 10 uses per instrument. Cost of new linear stapler is $251.76.

The experience accumulated in our institution over 3 years with more than 10 000 reuses of 10 different disposable laparoscopic instruments demonstrates that reuse of disposable laparoscopic instruments can be economical. The judicious choice of disposable and reusable instruments will provide the best possible tools for the surgeon performing laparoscopic procedures while maintaining patient safety and containing costs.

The recent arrival of so-called reusable disposable instruments with features that facilitate reprocessing (irrigation ports, plastics able to withstand autoclaving), although specifically designed for limited reuse, may provide another alternative to the problem of choosing the optimal equipment for all types of laparoscopic procedures at a reasonable cost.

The decision to reprocess disposable laparoscopic instruments will ultimately be made by individual hospitals only after careful evaluation of feasibility and anticipated economic benefits. Several guidelines and recommendations are available,[8–14] all of which stress demonstration of patient safety, establishment of reprocessing protocols, personnel training, quality control and cost analysis.

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SESAP VIII Question
Question SESAP VIII

Item 46

A 40-year-old woman undergoes uneventful laparoscopic cholecystectomy and has only mild, intermittent abdominal discomfort. Three days later, she and her husband travel several hundred miles to see a relative. She suddenly experiences severe, diffuse abdominal pain and prostration and is brought to the emergency department by ambulance.

Her abdomen is rigid with no bowel sounds. Blood pressure is 100/60 mm Hg, and pulse is 124/minute. Rectal tenderness is present; pelvic examination is limited because of pain and tenderness. Plain abdominal roentgenograms reveal only evidence of mild ileus. WBC count is 17,000/cu mm, with 90% polymorphonuclear leukocytes. Bilirubin is normal.

The most likely diagnosis is

(A) subphrenic abscess
(B) bile peritonitis
(C) acute pancreatitis
(D) suppurative cholangitis
(E) intestinal perforation

For the incomplete statement above, select the one completion for each that is best of the five given.

For the critique of Item 46 see page 158.

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