

Classifying Surgical Complications

A Critical Appraisal

Elco J. Veen, MD; Jessica Steenbruggen, MD; Jan A. Roukema, MD, PhD

Hypothesis: Inconsistency exists in methods of classifying complications after colorectal surgery with anastomosis, which may result in incomplete availability of data.

Design: Retrospective study.

Setting: Nonuniversity teaching hospital.

Patients: All patients with complications after colorectal surgery with anastomosis performed from January 1, 1995, through December 31, 2001.

Interventions: Incidence and type of complications and classification systems used were recorded. Complications were classified according to the systems of the Association of Surgery of the Netherlands and the Trauma Registry of the American College of Surgeons.

Main Outcome Measures: Classification of complications and systems used to record them.

Results: Colorectal surgery was performed in 505 patients. In 181 patients, 437 complications were re-

corded, and 350 (80%) of these events represented 13 types of complications. Different classification systems were used, and no consistent approach in classifying was seen. Anastomotic disruption (n=40), the most serious complication after colorectal surgery, was recorded as dehiscence 32 times (80%) in the Association of Surgery of the Netherlands system and as anastomotic leak (code 4001) 24 times (60%) in the Trauma Registry of the American College of Surgeons system.

Conclusions: Diverse classification systems were used for major complications after colorectal surgery. The differences in classifying seemed to be based on the interpretation of the recording physician. Emphasis should be placed on training physicians on a regular basis in documenting and classifying complications and providing feedback. The reporting process should focus on adequate and uniform classifying of events with major significance, eg, anastomotic disruption in colorectal surgery.

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COMPLICATIONS ARE ACCEPTED in the surgical literature as important outcome measures and are used as indicators for measuring quality. A weak point of using complications for this purpose lies in the reliability of the process for recording complications.¹ The incidence of recorded complications depends strongly on the validity of the recording systems and definitions used.^{2,3} Complications may be classified according to different classification systems.⁴⁻⁶ An optimal classification system would be unequivocal and lead to uniformity in classifying surgical complications.

In our surgical clinic, we use 2 different systems to classify complications; one was developed by the Association of Surgery of the Netherlands (ASN) and the other by the Trauma Registry of the American College of Surgeons (TRACS). How complications should be classified according to these systems has not been specified. The aim of this study was to gain information about the classifications used in the process of recording complications and to de-

termine whether there is a consistent approach to classifying complications.

METHODS

We analyzed data from all patients who experienced complications after colorectal surgery with anastomosis in the period from January 1, 1995, through December 31, 2001.

RECORDING OF COMPLICATIONS

At the beginning of 1995, an electronic database was implemented on all clinical wards of our department and complications were recorded prospectively. Our surgical clinic is part of a teaching hospital in which 9 surgeons and 12 residents participate. The physician who diagnosed the complication immediately recorded and classified it in all cases. Recording was done by a description in full text. Classification was done according to 1 of the 2 systems we use (ASN or TRACS). During the study period, discussion of every recorded complication was a standard part of the daily surgical team sessions. We used the definition of a complication as given by the ASN: "A complication is a condition or event, unfavorable to the patient's health, causing irreversible damage or requir-

Author Affiliations:
Department of Surgery,
St Elisabeth Hospital, Tilburg,
the Netherlands.

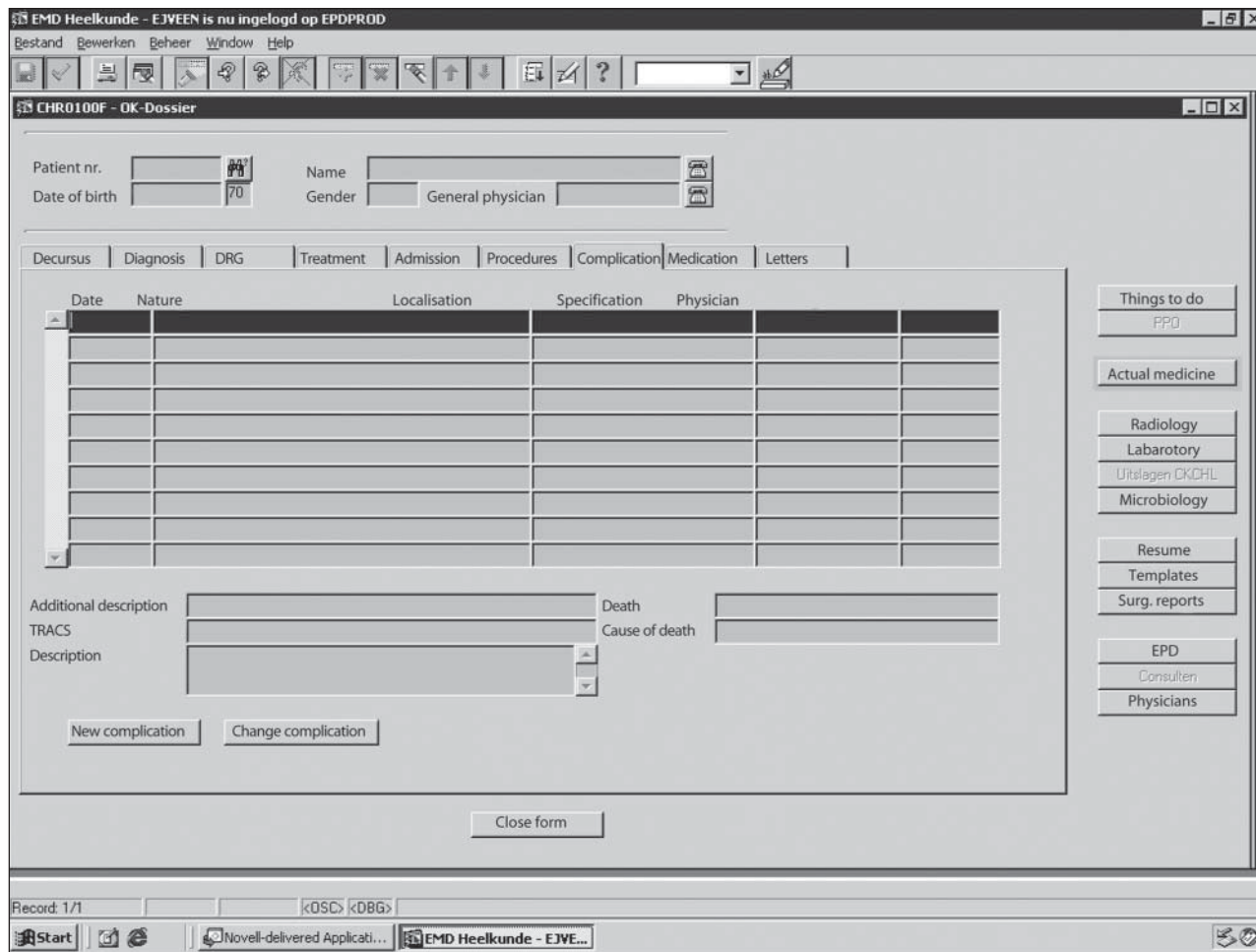


Figure 1. Complication sheet as used in the electronic patient file at the Department of Surgery, St Elisabeth Hospital, Tilburg, the Netherlands. DRG indicates diagnosis related group; TRACS, Trauma Registry of the American College of Surgeons.

ing a change in therapeutic policy.”⁵ All events occurring and noticed during the hospital stay or at the outpatient clinic were recorded. The complication sheet is shown in **Figure 1**.

CLASSIFICATION SYSTEMS

Our electronic database consists of 2 systems for classifying complications (ASN and TRACS). Neither system addresses the severity of complications.^{6,7} The ASN system uses 4 denominators to classify an event: nature of the complication, anatomic localization, specification, and additional description (**Figure 2**). The TRACS system was originally developed as a complication list to record the morbidity in trauma patient populations. The list explicitly defines complications and uses 4-digit codes.⁷ Although this list was developed for the trauma population, its design is broad and encompasses all complications applicable to general surgery.

All classifications used for each type of complication were analyzed for incidence, type of classification, and consistency. If different classifications were used for the same type of event, we considered classification to be inconsistent. Each system was analyzed separately, but this study was not intended to determine which system has the highest level of sensitivity.

ANASTOMOTIC DISRUPTION

As anastomotic disruption is the most serious sequela and an important outcome measure after colorectal surgery, particular attention was paid to the classification used for this com-

plication. In our clinic, we consider anastomotic disruption to be present whenever there is clinical evidence of it at laparotomy or when contrast radiography demonstrates a leak.

We consider the correct classification of anastomotic disruption according to the ASN system to be dehiscence, with a localization of colon, rectum, and anus, and no specification or additional description is given. In the TRACS system, anastomotic disruption is coded as 4001, which is defined as anastomotic disruption confirmed by roentgenogram or reoperation.

RESULTS

During the study period, 505 patients underwent colorectal surgery with primary anastomosis. In 324 patients (64%) there were no adverse events during the hospital stay. There were 437 complications recorded in 181 patients undergoing colorectal surgery. **Table 1** and **Table 2** show patient characteristics, surgical procedures performed, and number of complications noted.

Fifty types of adverse events were noted according to the descriptions used for recorded complications; most complications (204 [47%]) were infection related. Pulmonary complications were observed 39 times (9% of all complications), and cardiovascular complications, 41 times (9%).

Twelve types of complications excluding anastomotic disruption, occurring in 310 instances (71% of all

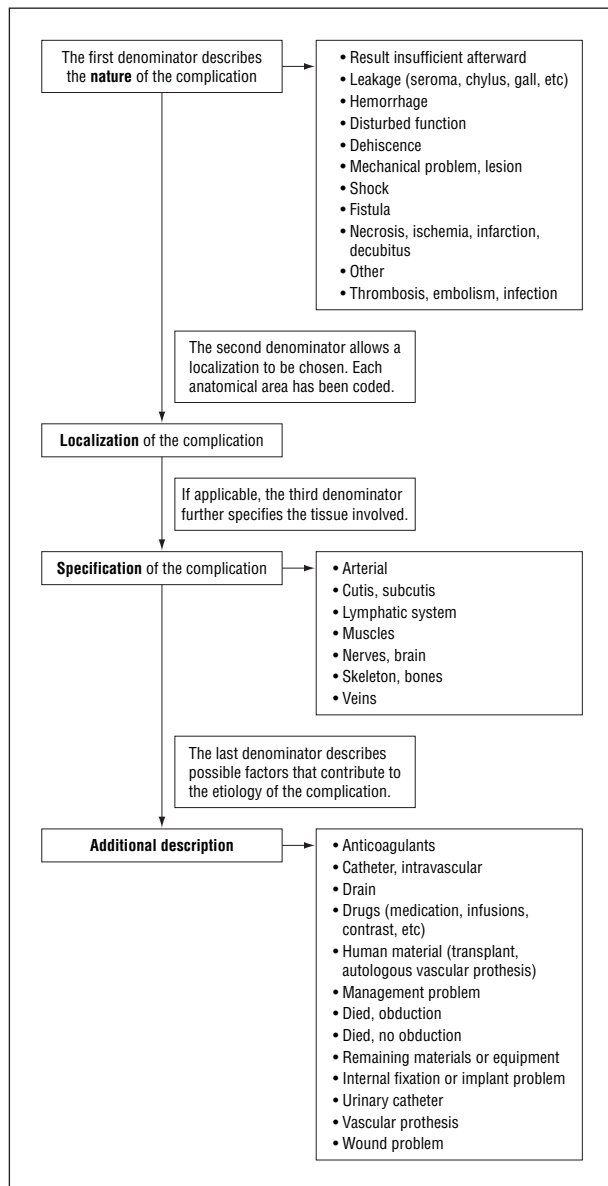


Figure 2. Classification of complications according to the Association of Surgeons in the Netherlands.

complications), were frequently recorded and were further analyzed (**Table 3** and **Table 4**).

ASN SYSTEM

There were 173 infection-related complications, and most of these events (157 [91%]) were correctly classified as infection. Sepsis (36 cases) was assigned to 4 different “nature of complication” categories: infection (23 [64%]), shock (6 [17%]), disturbed function (6 [17%]), and other (1 [3%]). In the remaining 137 infection-related complications, 3 events (2%) were differently classified. Fourteen separate localizations were used in the infection-related groups, and only the localization of pneumonia (lungs) was identical in all 24 cases in which it occurred (Table 3).

Among the 35 cardiovascular events (arrhythmia, congestive heart failure, and shock), 4 different natures of complication were noted, of which disturbed function (29 cases

Table 1. Patient Characteristics

Characteristic	Median	Range
Age, y	67	7-91
Patients without complications	64	7-91
Patients with complications	70	25-91
Hospital stay, d	13	4-114
Patients without complications	11	7-71
Patients with complications	16	4-114

Table 2. Clinical Details of Colorectal Surgical Procedures With Primary Anastomosis

	No. (%) of Patients (N = 505)	No. of Complications (n = 437)	No. of Patients With Complications (Row %) (n = 181)
Type of resection			
Hemicolectomy, right	81 (16)	54	23 (28)
Hemicolectomy, left	49 (10)	54	20 (41)
Sigmoid	168 (33)	160	66 (39)
Anterior resection	59 (12)	38	17 (29)
Low anterior resection	111 (22)	114	46 (41)
Colostomy closure	37 (7)	17	9 (24)
Diagnosis			
Malignancy	324 (64)	294	116 (36)
Inflammatory bowel disease	11 (2)	7	2 (18)
Diverticulitis	84 (17)	93	39 (46)
Colostomy closure	37 (7)	17	9 (24)
Other	48 (10)	25	14 (29)
Unknown	1 (0.2)	2	1 (100)

[83%]) was the chief one. Shock was less consistently classified, being designated as shock 4 times and as disturbed function 6 times. The localization denominator was used 32 times in the cardiovascular group. The localization *heart* was used in 23 (66%) of the 35 complications.

Respiratory failure (21 cases) and dehiscence or evisceration (16 cases) were mainly classified as disturbed function (19 [90%]) and dehiscence or evisceration (14 [88%]), respectively. The localization denominator for respiratory failure was used 20 times. For 18 (86%) of the 21 cases of respiratory failure the location was classified as lungs. For dehiscence or evisceration, the localization *abdominal wall/space* was most frequently used (8 cases [50%]).

Among the 13 types of most commonly recorded complications (those in Table 3 and Table 4 plus anastomotic disruption), the specification (71 [20%]) and additional description (167 [48%]) denominators were seldom used in the ASN system (in 71 [20%] and 167 [48%] of 350 cases, respectively).

TRACS SYSTEM

The complications shown in Table 4 were well described and coded in the TRACS system, although in some cases incorrect classifications were used. Sepsis (36 cases) and shock (10 cases) were the most frequently incorrectly classified. Four different TRACS codes were used for sepsis and 5 for shock.

Table 3. Most Common Complications After Colorectal Surgery and Their ASN Classifications*

Type of Complication	Nature	Localization	Specification	Additional Description
Arrhythmia (16)	Disturbed function (15) Other (1)	Heart (14) None (2)	None (16)	Management problem (1) Drugs (medication, etc) (2) Died with obduction (1) None (12)
Congestive heart failure (9)	Disturbed function (8) Leakage (seroma) (1)	Heart (7) Lungs (1) None (1)	Musculature (1) None (8)	Drugs (medication, etc) (2) Died with obduction (1) None (6)
Shock (10)	Disturbed function (6) Shock (4)	Circulation/blood (6) Heart (2) Internal milieu, etc (1) Multiple organs (1)	Musculature (2) Arterial (1) None (7)	Drugs (medication, etc) (1) None (9)
Pneumonia (24)	Infection (24)	Lungs (24)	None (24)	Human material (1) None (23)
Sepsis (36)	Shock (6) Disturbed function (6) Infection (23) Other (1)	Circulation/blood (20) Abdominal wall/space (2) Abdomen (1) Multiple organs (2) Heart (1) No localization (4) None (6)	Arterial (3) Veins (1) None (32)	Died with obduction (1) Died with no obduction (2) Drugs (medication, etc) (3) Catheter (vascular) (3) Wound problem (1) Human material (2) None (24)
Intra-abdominal abscess (27)	Infection (27)	Abdomen (12) Abdominal wall/space (7) Colon, rectum, anus (2) Circulation/blood (1) Bladder (1) Pelvis (1) None (3)	None (27)	Wound problem (11) None (16)
Line infection (10)	Infection (10)	Circulation/blood (4) Head, neck, brain (2) No localization (1) Thorax (1) Other (1) None (1)	Veins (3) None (7)	Catheter (vascular) (8) None (2)
Urinary tract infection (27)	Infection (25) Disturbed function (1) Hemorrhage (1)	Bladder (24) Kidney, ureter (2) Other (1)	None (27)	Urine catheter (6) Wound problem (1) Drain (1) Catheter (vascular) (1) None (18)
Wound infection (49)	Infection (48) Leakage (seroma) (1)	Abdominal wall/space (43) Abdomen (3) None (2) Inguinal region, etc (1)	Cutis, subcutis (20) None (29)	Wound problem (21) None (28)
Respiratory failure (21)	Disturbed function (19) Result insufficient afterward (1) Other (1)	Lungs (18) Thorax (1) None (1)	None (21)	Died with no obduction (2) Died with obduction (1) Wound problem (3) None (15)
Dehiscence (16)	Dehiscence (14) Mechanical problem, lesion (1) Result insufficient afterward (1)	Abdominal wall/ space (8) Abdomen (2) Colon, rectum, anus (1) None (5)	Cutis, subcutis (2) Musculature (9) None (5)	Wound problem (7) None (9)
Management-related events (65)	Dehiscence (1) Disturbed function (7) Hemorrhage (2) Infection (1) Mechanical problem, lesion (8) Other (42) Result insufficient afterward (4)	None (24) 16 different localizations used (41)	Veins (3) Arterial (2) Cutis, subcutis (3) None (57)	None (18) Drain (2) Catheter (vascular) (2) Drugs (3) Human material (1) Management problem (36) Remaining materials (1) Urine catheter (1) Wound problem (1)

Abbreviation: ASN, Association of Surgery of the Netherlands.

*Numbers of complications are given in parentheses. Included are 310 (71%) of the 437 complications.

MANAGEMENT-RELATED EVENTS

Sixty-five complications (15%) were classified as management-related events. The classification of this type of com-

plication is not unequivocal. In the ASN system, *other* (42 [65%]) was usually used to classify the nature, and 16 different locations were noted. The specification denominator was used only 8 times in these 65 cases (12%). Addi-

Table 4. Most Common Complications After Colorectal Surgery and Their TRACS Classifications*

Type of Complication	TRACS Classification
Arrhythmia (16)	3501, Arrhythmia (13) 3599, Other cardiovascular (3)
Congestive heart failure (9)	3504, Congestive heart failure (8) 3599, Other cardiovascular (1)
Shock (10)	3503, Cardiogenic shock (1) 3508, Shock (3) 3599, Other cardiovascular (4) 8501, Anesthetic complication (1) 8503, Fluid and electrolytes (1)
Pneumonia (24)	3003, Aspiration/pneumonia (4) 3004, Atelectasis (1) 3008, Pneumonia (19)
Sepsis (36)	3508, Shock (1) 5503, Intra-abdominal abscess (1) 5506, Sepsislike syndrome (13) 5507, Sepsis (21)
Intra-abdominal abscess (27)	3001, Abscess, excludes empyema (2) 4099, Other gastrointestinal (1) 5503, Intra-abdominal abscess (24)
Line infection (10)	5504, Line infection (8) 5507, Sepsis (1) 8599, Other miscellaneous (1)
Urinary tract infection (27)	5507, Sepsis (1) 6003, Urinary tract infection, early (9) 6004, Urinary tract infection, late (16) 6099, Other renal/genitourinary (1)
Wound infection (49)	5509, Wound infection (43) 5503, Intra-abdominal abscess (3) 4003, Dehiscence/evisceration (1) 4099, Other gastrointestinal (1) None (1)
Respiratory failure (21)	3015, Respiratory failure (19) 1009, Other airway (1) None (1)
Dehiscence (16)	4003, Dehiscence/evisceration (12) 8599, Other miscellaneous (1) 6506, Loss of reduction/fixation (1) 5509, Wound infection (1) None (1)
Management-related events (65)	None (1) Hospital or provider errors (47) 9001-9010† (33) 8599, Other miscellaneous (14) Remaining complications divided among 12 different codes (17)

Abbreviation: TRACS, Trauma Registry of the American College of Surgeons.

*Numbers of complications are given in parentheses. Included are 310 (71%) of the 437 complications.

†Codes 9001 through 9010 consist of delays in disposition, in trauma team activation, to operating room, in physician response, in obtaining consultation, and in diagnosis; errors in diagnosis, judgment, and technique; and incomplete hospital record, respectively.

tional description was applied 47 times, of which 36 were recorded as management problems. In the TRACS system, 21 different codes were used. Most of them could be classified as hospital or provider errors (47 [72%]).

ANASTOMOTIC DISRUPTION

Forty anastomotic disruptions occurred after colorectal surgery. According to the ASN classification system, 32 (80%) were classified as dehiscence (**Table 5**). According to the TRACS system, 24 (60%) were coded as 4001 (anastomotic leak), 14 were coded 4003 (dehiscence, evis-

Table 5. Classifications for 40 Cases of Anastomotic Disruption After Colorectal Surgery According to the ASN System*

Denominator	Classification
Nature of complication	Infection (2) Result insufficient afterward (3) Necrosis, ischemia, infarction, decubitus (1) Fistula (1) Dehiscence (32) Mechanical problem or lesion (1)
Localization	Colon, rectum, anus (35) Abdomen (1) Abdominal wall/space (1) Small bowel (1) None (2)
Specification	Cutis, subcutis (1) None (39)
Additional description	Died, no obduction (2) Wound-related problem (24) None (14)

Abbreviation: ASN, Association of Surgery of the Netherlands.

*Numbers of complications are given in parentheses. Included are 40 (9%) of the 437 complications.

ceration), and one each was coded 4009 (peritonitis) and 5503 (intra-abdominal abscess).

COMMENT

Complications are accepted indicators of quality of surgical care and should create a basis for quality improvement.⁷ The utility of a complication as a measure of quality depends on the magnitude of the problem, measured in terms of both incidence and consequences.⁸

In the surgical literature, however, inconsistent methods of reporting complications make the use of complications for quality measurement unreliable, and great variability is observed in definitions and classification systems for recording complications.⁹⁻¹¹ This study evaluated classifications of complications used in the ASN and TRACS systems in 1 surgical clinic to assess consistency (or inconsistency).

For 13 types of frequently recorded complications (350 cases [80%]), no consistent approach for classification was seen, independent of the system used. Anastomotic disruption (40 cases), the most important sequela after colorectal surgery, was classified incorrectly in the ASN system 8 times (20%) and in the TRACS system 15 times (40%).

CAUSE OF INCONSISTENT CLASSIFICATIONS

As both systems showed inconsistency in classifications used for recording complications, the differences in classifying seem to depend on the interpretation of the recording physician in our clinic. Volk et al,¹² in their audit of a regional cardiac surgery registry, documented an overall inconsistency rate of 9.9% and also demonstrated that surgeon data collection was primarily responsible for the inconsistencies.

Although physicians are familiar with the systems, they are inadequately trained in using them properly. Subjectivity remains a potential limitation in the use of classifications, even if all recorded complications are discussed, as in our clinic, at a general team session.¹¹ It may be ques-

tioned whether physicians should continue to record and classify complications. Some authors advocate the use of specific data managers, whereas others recommend trained nurses or specific members of the surgical team.¹³⁻¹⁵ Like Healey et al,⁴ we believe that the physician at the scene should be the one identifying and recording the event and should not relinquish this task to administrative personnel or nurses. Adjustments should be sought to reduce the inaccuracies in classifying complications.

Especially in charting and coding, inaccuracies will lead to inadequate data and, as a consequence, to wrong conclusions about some aspects of the quality of care.^{16,17} We believe that the recording should be done prospectively by the physician who diagnoses a complication, and classifying should be performed by an administrator qualified to do so.

CLASSIFICATION SYSTEMS

In the surgical literature, classification systems for recording complications remain a matter of debate. Usually systems are related to specific surgical procedures, or are developed and used in one surgical clinic with a specific focus and interest in the recording of complications.¹⁸⁻²² The system of the ASN records adverse events according to their nature. Assessing the nature of adverse events discloses possible causal factors in the process of care and is essential for determining and improving the quality of surgery.²³

Others plead for systems focusing on therapeutic consequences, stratified by severity. Recently, Dindo et al¹¹ presented a fine modification of their group's classification system.³ The systems used in our clinic lack severity stratification, which is a limitation in the recording system. Therefore, we recently implemented the system of Clavien et al³ in our electronic medical files to improve our method of recording complications.

RECOMMENDATIONS FOR IMPROVING DATA ACCURACY

The usefulness of a database strongly depends on the quality of collected data, which should therefore be assessed and validated.²⁴ We recently started a study to validate our registration system, and we are using the data from the University Medical Centre Utrecht as a benchmark.¹³

Feedback to users on their performance in the process of registration, together with immediate data capture, has been advocated in the literature to improve the accuracy and completeness of data and the usefulness of surgical monitoring systems.²⁵ More important, however, may be to limit physicians in classifying complications until they have had sufficient training and familiarity with the registries they use.

Finally, we believe that the process of recording complications has to be narrowed, and focus should be placed on events of major importance and consequences for the patient, for instance, anastomotic disruption in colorectal surgery.

CONCLUSIONS

This evaluation of recorded complications in our clinic demonstrates differences in the classifications used for

major complications after colorectal surgery. This is primarily caused by insufficient training of physicians in the use of the classification system. To overcome this problem, emphasis should be placed on providing feedback and training physicians on a regular basis in documentation and classification of complications. More important is to focus the recording process on adequate and uniform classifying of events with major significance, such as anastomotic disruption in colorectal surgery.

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Correspondence: Jan A. Roukema, MD, PhD, Department of Surgery, St Elisabeth Hospital, PO Box 90052, 5600 PD Tilburg, the Netherlands (a.roukema@elisabeth.nl).

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REFERENCES

1. Martin RC II, Brennan MF, Jaques DP. Quality of complication reporting in the surgical literature. *Ann Surg.* 2002;235:803-813.
2. Gunnarsson U, Seligsohn E, Jestin P, Pahlman LP. Registration and validity of surgical complications in colorectal cancer surgery. *Br J Surg.* 2003;90:454-459.
3. Clavien P-A, Sanabria JR, Strasberg SM. Proposed classification of complications of surgery with examples of utility in cholecystectomy. *Surgery.* 1992;111:518-526.
4. Healey MA, Shackford SR, Osler TM, Rogers FB, Burns E. Complications in surgical patients. *Arch Surg.* 2002;137:611-618.
5. Kievit J, Marang-van de Mheen PJ. *The National Surgical Adverse Event Registration: A Study Protocol by the Association of Surgery of the Netherlands.* Protocol version 3.5. Utrecht: Association of Surgeons of the Netherlands; 1995.
6. American College of Surgeons Committee on Trauma. *Resources for the Optimal Care of the Injured Patient.* Chicago, Ill: American College of Surgeons; 1999.
7. Casparie AF. Postoperative wound infections: a useful indication of the quality of care [in Dutch]? *Ned Tijdschr Geneesk.* 2000;144:460-462.
8. Fleming ST. Complications, adverse events, and iatrogenesis: classifications and quality of care measurement issues. *Clin Perform Qual Health Care.* 1996;4:137-147.
9. Bruce J, Russell EM, Mollison J, Krukowski ZH. The measurement and monitoring of surgical adverse events. *Health Technol Assess.* 2001;5:1-194.
10. Russell EM, Bruce J, Krukowski ZH. Systematic review of the quality of surgical mortality monitoring. *Br J Surg.* 2003;90:527-532.
11. Dindo D, Demartines N, Clavien P-A. Classification of surgical complications. *Ann Surg.* 2004;240:205-213.
12. Volk T, Hahn L, Hayden R, Abel J, Puterman ML, Tyers GF. Reliability audit of a regional cardiac surgery registry. *J Thorac Cardiovasc Surg.* 1997;114:903-910.
13. Veltkamp S. *Complications in Surgery* [dissertation]. Utrecht, the Netherlands: University Medical Centre Utrecht; 2001.
14. Gawande AA, Thomas EJ, Zinner MJ, Brennan TA. The incidence and nature of adverse events in Colorado and Utah in 1992. *Surgery.* 1999;126:66-75.
15. Leape LL, Brennan TA, Laird N, et al. The nature of adverse events in hospitalized patients. *N Engl J Med.* 1991;324:377-384.
16. Pettigrew RA, van Rij AM. Coding for surgical audit. *Aust N Z J Surg.* 1990;60:365-371.
17. Smith RL, Bohl JK, McElearney ST, et al. Wound infection after elective colorectal resection. *Ann Surg.* 2004;239:599-607.
18. Azimuddin K, Rosen L, Reed JF III. Computerized assessment of complication after colorectal surgery: is it valid? *Dis Colon Rectum.* 2001;44:500-505.
19. Obertop H, Gouma DJ. Complications in surgery: let's face them. *Dig Surg.* 2002;19:83-85.
20. Van Geldere D, Fa-Si-Oen P, Noach LA, Rietra PJGM, Peterse JL, Boom RPA. Complications after colorectal surgery without mechanical bowel preparation. *J Am Coll Surg.* 2002;194:40-47.
21. Aitken RJ, Nixon SJ, Ruckley CV. Lothian surgical audit. *Lancet.* 1997;350:800-804.
22. Roukema JA, Van der Werken CHR, Leenen LPH. Registration of postoperative complications to improve the results of surgery [in Dutch]. *Ned Tijdschr Geneesk.* 1996;140:781-784.
23. Rhodes RS. Quality in surgery: from outcomes to process—and back again. *Surgery.* 1999;126:76-77.
24. van der Meulen JH, Jacob M, Copley L. Assessing the quality of the data in a transplant registry. *Transplantation.* 2003;75:2164-2167.
25. Barrie JL, Marsh DR. Quality of data in the Manchester orthopaedic database. *BMJ.* 1992;304:159-162.