

An orthopedic complication-registration system

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Quality control is gaining ever-increasing interest in the evaluation of a surgical practice (Adar 1982, Stock et al. 1982, Castleden et al. 1992). Orthopedic surgeons have long been used to evaluating the results of various surgical techniques. A large proportion of clinical scientific research has been performed in retrospect, with the primary aim of reporting the percentages of patients with good, moderate or poor results. Perioperative and postoperative complications are generally mentioned, but it is important to bear in mind that in retrospective studies not all complications will have been recorded in the medical files and it will depend greatly on the opinion of the authors whether or not a particular condition is considered to be a complication.

In 1991, we started registering complications prospectively. It is well-known that complications are responsible for a considerable proportion of postoperative morbidity and that they form an important factor in the patients' opinions about the quality of surgical procedures (Tjoëng and Janzon 1988, Noer et al. 1991). By gaining more insight into the complications, our main aims were to learn from any errors, reduce the incidence of complications and consequently produce a cost-saving effect.

Methods

The complication-registration system was developed to make full and systematic records of all the perioperative and postoperative complications which occurred up to 1 year following orthopedic surgery. The objective was to record the data in such a way that complications could be displayed in relation to the surgical procedure performed, preferably as a percentage of the total number of any particular procedure per year.

Definition

Defining conditions which should be considered as complications is difficult and will depend strongly on the personal opinion of those using the system. To be able to distinguish at a later date between

complications which can be avoided and those which cannot, it is useful to make the registration of complications and errors as broad as possible. We used the following definition of a complication: any unintentional development during or after a surgical procedure.

Coding

The complication-registration system is based on 2 coding systems:

A. A list of complication codes divided into a code for the location of a complication and a code for the nature of the complication. By applying crosswise combination to these subcodes, almost all complications can be accounted for.

B. A list of procedure codes, in which each procedure can be described adequately with 1 code. It is not possible to assign multiple codes to a particular procedure, because the unequivocal relationship between the procedure performed and the complication would be lost. Cases requiring several operations, for example, patients with multiple injuries, can be assigned several codes, each with any accompanying complications.

The coding system for the complications was designed as comprehensively as possible; general complications can also be entered. None of the existing coding systems could be used for the surgical procedures or the diagnosis of a complication, because the other systems do not provide a description that is accurate enough (ICD9-cm 1986), or the coding system is too extensive.

Logistics

To register every patient who undergoes an outpatient or clinical operation, a simple double-side printed A4-size form was designed to follow the same routine as a medical file (Figure 1). The form is inserted into the patient's medical file on admission and removed on discharge. Every procedure must be filled in, whether or not a complication occurred. The form is blue to distinguish it from the (red) forms which are filled in at follow-up visits. The red form is only used to register late complica-

Figure 1. The frontside (this page) and the backside (next page) of the complication form, with all the complication codes and the codes of the procedures.

COMPLICATION FORM		
Operation date:	<	>
Procedure code:	Patient ID sticker	
Surgeon:	<	>
Assistant:	<	>
Complication Y / N	Description	
Code 1st complication:	Date 1st:	- -
Code 2nd complication:	Date 2nd:	- -
Code 3rd complication:	Date 3rd:	- -
LOCATION	NATURE OF COMPLICATION	
Axial skeleton	Wound	Neural
10 Skull	010 infection around sutures	090 spinal cord lesion
11 Cervical vertebrae	011 superficial infection	091 dura lesion
12 Thoracic vertebrae	012 deep infection	092 nerve root lesion
13 Lumbar vertebrae	013 local wound necrosis	093 plexus lesion
14 Sacrum		094 nerve lesion
	Muscle	095 post-spinal headache
Trunk	020 rupture	
20 Clavicle	021 avulsion	Vascular
21 Scapula	022 bleeding	100 secondary bleeding/hematoma
22 Thorax/Rib		101 transection
23 Sternum	Tendon	102 compartment syndrome
24 Pelvis	030 rupture	103 Sudeck's dystrophy
25 Back	031 avulsion	104 thrombosis
26 Abdomen/Flank	032 luxation	105 embolus
	033 necrosis	
Upper extremity	Capsule and ligaments	Traction
30 Shoulder	040 subluxation	110 unstable
31 Humerus/Upper arm	041 luxation	111 loosening
32 Elbow	042 capsulitis/restricted function	
33 Forearm	043 periarticular ossification	Miscellaneous
34 Radius	044 synovitis/arthritis	120 surgical instrument failure
35 Ulna		121 osteosynthesis material not totally removed
36 Wrist	Osseous	122 persistent instability
37 Carpus	050 fissure	123 persistent pain
38 Metacarpus	051 fracture	124 persistent deformity
39 Phalanges/ Fingers/Thumb	052 perforation	125 interruption of sterility
	053 pseudarthrosis	
Lower extremity	054 malalignment	General
40 Hip	055 dislocation	130 deceased
41 Femur/Upper leg	056 insufficient repositioning	131 dysrhythmia
42 Knee	057 osteomyelitis	132 organ insufficiency
43 Lower leg	058 necrosis	133 infarct
44 Tibia		134 infected organ
45 Fibula	Chondral	135 retention
46 Ankle	060 damage	136 bleeding organ
47 Heel/Tarsus	061 discitis	137 aspiration
48 Metatarsus		138 decubitus ulcer
49 Toes	Osteosynthesis	139 skin lesion
	070 breakage of fixation materials	140 fever of unknown origin
General	071 protrusion of fixation materials	141 psychological decompensation
50 Lung	072 malposition	
51 Heart	073 fixation material too long	
52 Kidney	074 insufficient stability	
53 Bladder		
54 Central nervous system	Prosthesis	
55 Gastrointestinal	080 malpositioning	
56 Venous system	081 damage	
57 Arterial system	082 breakage of prosthesis	
58 Total	083 prosthesis infection	
	084 aseptic loosening	
	085 wrong size of prosthesis	

SHOULDER

- 101 Subacromial decompression, open
- 102 with cuff repair
- 123 arthroscopic
- 103 Lateral clavicular resection
- 104 Osteosynthesis clavicular fracture
- 105 Arthrotomy/synovectomy shoulder
- 106 Arthroscopy shoulder
- 107 Arthroscopic stabilisation
- 109 Bankart's procedure or alternative
- 110 Shoulder hemi-prosthesis
- 111 Total shoulder prosthesis
- 112 Shoulder arthrodesis
- 113 Subcapital humeral fracture (OS)
- 114 Humeral shaft fracture, plate OS
- 115 external fixation
- 116 intramedullary nail
- 117 Humeral pseudarthrosis repair
- 118 Upper arm exarticulation
- 119 Upper arm amputation
- 120 Manipulation under anesthesia
- 121 Resection shoulder tumor
- 122 Arthritis drainage
- 199 Other shoulder/upper arm surgery

ELBOW/FOREARM

- 201 Supracondylar humeral fracture
 - closed, K wires
 - open reduction
- 203 Intracondylar humeral fracture
- 204 Olecranon fracture
- 205 Radial head fracture
- 206 Radial head resection
- 207 Osteosynthesis radius/ulna
- 208 Pseudarthrosis radius/ulna
- 209 Osteotomy radius/ulna
- 210 Arthritis elbow
- 211 Arthroscopy elbow
- 212 Arthrotomy/arthrolysis elbow
- 213 Arthrodesis elbow
- 214 Prosthesis elbow
- 215 Arthroplasty elbow
- 216 Ulnar nerve release
- 217 Deep radial nerve release
- 218 Synovectomy elbow with radial head resection
- 219 Resection elbow tumor/forearm
- 220 Epicondylitis release
- 299 Other elbow/forearm surgery

WRIST/HAND

- 301 Distal radial fracture, OS
- 302 external fixation
- 303 Carpal subluxation-luxation /capsulodesis
- 304 Arthritis wrist
- 305 Wrist prosthesis
- 306 Arthroscopy wrist
- 307 Arthrodesis wrist
- 324 Intercarpal arthrodesis
- 308 Metacarpal fracture (OS)
- 309 Phalangeal fracture (OS)
- 310 Reconstruction extensor tendon
- 311 Synovectomy extensor tendons
- 325 Synovectomy flexor tendons
- 312 Synovectomy/arthrotomy wrist
- 313 Synovectomy MCP with rerouting
- 314 MCP prosthesis with rerouting
- 315 Arthrodesis finger joints
- 316 Arthrodesis CMC
- 328 Resection CMC
- 317 Carpal tunnel release
- 318 Trigger finger release (+Quervain)
- 319 Ulnar head resection
- 320 Arthrotomy finger/thumb

- 321 Finger prosthesis
- 322 Suture collateral ligament MCP-I
- 323 Resection tumor hand/wrist
- 326 Boutonnière's correction finger/thumb
- 327 Swan neck's correction finger/thumb
- 399 Other wrist/hand surgery

VERTEBRAL COLUMN

- 401 Halo traction
- 402 Torticollis correction
- 403 Cerv. spondylodesis (fract., tumor)
- 404 Cerv. spondylodesis (degen.)
- 405 Thor. spondylodesis (fract., tumor)
- 406 Thor. spondylodesis (scoliosis)
- 407 Thor.spondylodesis (& osteotomy)
- 408 Lumbar spondylodesis (fr., tumor)
- 409 Lumbar spondylodesis (degen.)
- 410 Spondylodesis (spondyliolsthesis)
- 411 Decompression laminectomy
- 412 Nuclear discectomy
- 413 Vertebral puncture
- 414 Pelvic fracture (extern fixation)
- 415 Pelvic fracture (osteosynthesis)
- 416 Discography
- 417 Bone harvesting from iliac crest
- 499 Other vertebral column surgery

HIP/UPPER LEG

- 501 Primary total hip prosthesis (THP)
- 502 Cup revision THP
- 503 Stem revision THP
- 504 Cup and stem revision THP
- 505 Hemi arthroplasty
- 506 PAO removal
- 507 Removal total hip prosthesis
- 508 Inter/subtrochanteric osteotomy
- 509 Pelvic osteotomy
- 510 Shelf enlargement procedure
- 511 Osteosynthesis collum fracture
- 512 perthrochanteric fracture
- 513 Femur shaft fracture, plate OS
- 514 intramedullary fixation
- 515 Femur shaft extension
- 516 Supracond. femoral osteotomy
- 517 Coxitis drainage
- 518 Fixation epiphysiolysis
- 519 Hip arthrotomy
- 520 Closed reduction of hip luxation
- 521 Open reduction of hip luxation
- 522 Obturator nerve resection and adductor tenotomy
- 523 Phemister's procedure
- 524 Hip exarticulation
- 525 Tumor resection hip/upper leg
- 526 Osteomyelitis resection
- 527 Femoral inversion procedure (Van Nes)
- 528 Hip/core biopsy
- 529 Upper leg amputation
- 530 Femoral pseudarthrosis repair
- 531 Hip puncture
- 599 Other hip/upper leg surgery

KNEE/LOWER LEG

- 601 Primary total knee prosthesis
- 602 Revision total knee prosthesis
- 603 Tibial head osteotomy
- 604 Lengthening procedure lower leg
- 605 Arthritis knee
- 606 Arthrotomy knee
- 607 Arthroscopy, diagnostic
- 608 menisectomy, corp. lib.
- 609 meniscus suturing

- 610 Reconstruction of
 - anterior cruciate ligament
 - posterior cruciate ligament
 - collateral ligament
- 612 Perichondrium transplantation
- 613 Arthrolysis knee
- 614 Knee manipulation under anesthesia
- 615 OS tibia plateau fracture
- 616 Tibial shaft fracture, plate OS
- 617 intramedullary nail
- 618 external fixation
- 619 Pseudarthrosis repair
- 620 Resection lower leg tumor
- 621 Osteomyelitis tibia
- 622 Patellar fracture
- 623 Tuberosity transpositioning
- 624 Synovectomy knee
- 625 Triceps myototomy
- 626 Achilles tendon repair
- 627 Achilles tendon lengthening
- 628 Osteotomy lower leg
- 629 Knee prosthesis removal
- 630 Exarticulation knee
- 631 Lower leg amputation
- 632 Arthrodesis knee
- 633 Exploration knee (neuroma)
- 634 Patellar-femoral prosthesis
- 635 Baker's cyst resection
- 699 Other knee/lower leg surgery

ANKLE/FOOT

- 701 Ankle fracture
- 702 Pilon fracture
- 703 Talus fracture
- 704 Calcaneus fracture
- 705 Subtalar/triple arthrodesis
- 706 Arthrodesis ankle
- 707 Arthroscopy ankle
- 708 Arthrotomy ankle
- 709 Synovectomy ankle
- 710 Arthritis ankle
- 711 Osteomyelitis tarsus
- 712 MTP 1 arthrodesis
- 713 MT 1 corrective osteotomy
- 730 MTP arthroscopy
- 714 Keller-Brandes procedure
- 715 Decapitation forefoot
- 716 Helal osteotomy
- 717 Hammer toe correction
- 726 Corrective surgery toes (extensive)
- 718 Tendon transpositioning foot/ankle
- 719 Club foot release
- 720 Hollow foot treatment
- 721 Tarsal tunnel release
- 722 Exarticulation ankle
- 723 Amputation forefoot
- 724 Amputation toe
- 725 Haglund's exostosis resection
- 727 Tumor resection ankle/foot
- 728 Ankle prosthesis
- 729 Corrective surgery ankle ligaments
- 799 Other ankle/foot surgery

GENERAL SURGERY

- 801 Removal plate, cerclage
- 802 Removal intramedullary nail
- 803 Biopsy extremities
- 805 Abscess incision
- 806 Soft tissue excision/incision/surg.
- 808 Bunion/exophyt extirpation
- 809 Wire traction
- 810 Removal/exchange genta. beads
- 811 Cryosurgery
- 812 Split skin transplantation

Table 1. Sample data from 1992-1993

Procedure/ Location	Complication	N	% uncompl.	n
<i>Reconstruction anterior cruciate ligament</i>		71	77	
Knee	surgical instrument failure			4
Knee	capsulitis/restricted function			3
Knee	secondary bleeding/hematoma			3
Knee	insufficient stability osteos.			3
Knee	superficial infection			1
Knee	persistant instability			1
Lower leg	deep infection			1
Central nervous	post spinal headache			1
<i>Tibial shaft fracture (external fixation)</i>		22	50	
Lower leg	superficial infection			5
Lower leg	malalignment			3
Lower leg	insufficient reduction			1
Lower leg	secondary bleeding/hematoma			1
Tibia	pseudarthrosis			1
<i>Subacromial decompression (open)</i>		59	86	
Shoulder	deep infection			2
Shoulder	superficial infection			1
Shoulder	infection around suture			1
Shoulder	persistant pain			1
Scapula	fracture			1
Humerus/upper arm	skin lesion			1
Humerus/upper arm	Südeck's dystrophy			1
Bladder	organ insufficiency			1
<i>Arthroscopy knee (meniscectomy, corp.lib.)</i>		363	95	
Knee	cartilage damage			5
Knee	superficial infection			4
Knee	uncomplete removal of material			2
Knee	capsulitis/restricted function			1
Knee	synovitis			1
Knee	nerve lesion			1
Knee	persistant deformity			1
Knee	secondary bleeding/hematoma			1
Knee	surgical instrument failure			1
Central nervous	post spinal headache			1
Alimentary tract	bleeding organ			1

Table 2. Hemi arthroplasty, bipolar 1992 and unipolar 1993

Procedure/Period Location	Complication	N	% uncompl.	n
<i>Hemi arthroplasty of the hip, bipolar type</i>		34	47	
Hip	luxation			6
Hip	superficial infection			2
Hip	prosthesis malpositioning			1
General	deceased			1
Heart	insufficiency			2
Heart	infarction			1
Heart	dysrhythmia			1
Lung	insufficiency			1
Central nervous	infarction			1
Bladder	infected organ			6
Kidney	infected organ			3
Lung	infected organ			1
Lung	aspiration			1
Sacrum	decubitus ulcer			1
Pelvis	decubitus ulcer			1
Heel/Metatarsals	decubitus ulcer			1
Central nervous	psychological decompensation			1
<i>Hemi arthroplasty of the hip, unipolar</i>		27	41	
Hip	deep infection			2
Hip	prosthesis infection			1
Femur/Upper leg	deep infection			1
Hip	infection around sutures			1
Femur/Upper leg	fissure			3
Hip	secondary bleeding/hematoma			2
Hip	surgical instrument failure			2
Hip	prosthesis malpositioning			1
Hip	luxation			1
Hip	periarticular ossification			1
Bladder	infected organ			3
Gastrointestinal	bleeding			1
Heel/Tarsus	decubitus ulcer			1
Central nervous	psychological decompensation			2

tions and it supplements the blue form. A complete list of complication codes and surgical procedure codes can be found on the front and back of both forms.

Registration

Each surgical procedure is recorded only once. The form requests a minimum of patient data: name, date of birth and hospital number, plus the date of surgery, the names of the surgeon and surgical assistant and the procedure code (Figure 1, top of the form). If a surgical complication arises, the 2 complication codes and the date must be filled in. Registration data were kept to a minimum to save time during computer input. We wrote our own computer software in Turbo Pascal and this can be installed on any personal computer with a hard disk and an MS/DOS operating system.

Results

Owing to the diversity of data entered into the computer, it is important to be able to display them in the form of a report. Therefore, a great deal of time and effort were spent on the layout of the various reports. 3 main types of report can be drawn up using the computer data:

A. A report on the surgical procedures performed (per year or any other interval) for the department as a whole, or per surgeon or surgical assistant.

B. A patient-oriented complication report. Data on each surgical procedure can be displayed by means of the patient data, including the surgeons' names, the operation date and the occurrence of any complications. Reports can also be obtained per surgeon or surgical assistant.

C. A department-oriented complication report, without any patient data (Tables 1 and 2). A report

Table 3. Procedures performed more than 10 times in 1992-1993, number and percentage uncomplicated

Procedure	1992		1993	
Shoulder/upper arm				
Subacromial decompress, open	34	88	25	84
Arthroscopy shoulder	18	100	19	95
Bankart's procedure or alternative	13	77	13	77
Elbow/forearm				
Synovectomy elbow and radial head resection	2	100	13	92
Wrist/hand				
Carpal tunnel release	14	93	13	100
Trigger finger release (+Quervain)	17	100	18	89
Hip/upper leg				
Primary THP	123	68	111	63
Cup revision THP	15	73	7	71
Cup and stem revision THP	17	59	17	53
Hemi-arthroplasty	34	47	27	41
Inter/subtrochanter osteotomy	16	88	17	59
Pelvic osteotomy	17	65	14	64
Femur shaft fracture, plate osteosynthesis	3	67	13	62
Femur shaft fracture, intramedullary fixation)	15	80	6	83
Hip arthrotomy	16	100	8	88
Tumor resection hip/upper leg	11	73	23	83
Knee/lower leg				
Primary total knee prosthesis	37	70	45	62
Tibial head osteotomy	30	77	24	67
Arthroscopy, diagnostic)	207	97	119	100
Arthroscopy, meniscectomy, corpus liberum)	167	92	196	97
Reconstruction anterior cruciate ligament	38	79	33	76
Knee manipulation under anesthesia	8	63	10	80
Tibia shaft fracture, external fixation	11	64	11	36
Resection lower leg tumor	13	69	4	75
Achilles tendon repair	13	100	5	100
Ankle/foot				
Ankle fracture (osteosynthesis)	22	96	30	80
Subtalar/triple arthrodesis	5	40	16	88
Arthrodesis ankle	9	78	9	78
Arthroscopy ankle	17	94	10	100
MTP 1 arthrodesis	9	89	14	79
MTP 1 corrective osteotomy	19	74	23	78
Keller-Brandes procedure	8	88	10	90
Decapitation forefoot	6	100	11	100
Hammer toe correction	35	97	66	91
Tendon transpositioning foot/ankle	11	73	7	71
Club foot release	11	100	16	81
General surgery				
Removal of plate, cerclage	133	89	127	90
Removal of intramedullary nail	32	84	22	90
Biopsy extremities	66	96	65	92
Soft tissue excision/incision/surgery	31	84	52	89
Bunion/exophyt extirpation	30	93	23	96
Removal/exchange gentamicin beads	15	93	27	93

can be made concerning all the complications which occurred in any given period, or per surgical procedure.

Particularly the latter types of report are extremely useful and informative. Through their simple and orderly layout, they provide direct insight into the quality aspects of orthopedic surgery.

For example, we found a high percentage of luxations after hemi-arthroplasties of the hip in 1992 (Table 2). This was a reason to change this implant

(a bipolar type) for another implant (a unipolar type). The incidence of luxations decreased in the following year, 1993.

All procedures, which were performed more than 10 times in the year 1992 or 1993, are listed in Table 3. In this table, the nature of the complications is not shown. However, it is clear that many procedures have about the same complication rate in these 2 years.

Discussion

In practice, our orthopedic complication-registration system can fulfil several different functions. For example, the data displayed on type-A reports can be used to make an annual report, output figures and to provide trainee doctors with a survey of the surgical procedures that they have performed.

The type-B reports can be used during periodic conferences about complications. The complications (and, if appropriate, the patient's medical file and radiographs) can be reviewed and discussed in the department, with the aim of broadening experience and learning from any undesired consequences of surgery.

The type-C reports can also be used for making an annual report. In addition, these reports will clearly display any important trends (for example, an increased incidence of urinary tract infections) which may or may not have an explanation (for example, resulting from a new postoperative protocol).

Although it offers many advantages, the registration system also has a few drawbacks, for example, the need to fill in the complication form for any surgical procedure performed besides the writing of a report in a patient's file, and the freedom of choice about registering a complication. This is a matter of self-discipline, particularly with regard to complications which are detected at follow-up visits (Law et al. 1990). A prospective multicenter registration of postoperative complications in orthopedics has been performed in Denmark (Noer et al. 1991), but this system aimed mainly to register infections. In their system other orthopedic complications were registered only in general. At our department we have

used the complication-registration system since 1 January 1992. During this time, it has become clear that many complications arise and that the percentages of uncomplicated operations are lower than we initially assumed, probably because complications are being registered prospectively and as broadly as possible, i.e., including even minor problems.

Until now as many as 10 orthopedic clinics in The Netherlands have adopted our complication-registration system.

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