

Assessment of Avoidable Readmissions in a Visceral Surgery Department with an Algorithm: Methodology, Analysis and Measures for Improvement

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Abstract

Background Standardized quality indicators assessing avoidable readmission become increasingly important in health care. They can identify improvements area and contribute to enhance the care delivered. However, the way of using them in practice was rarely described.

Methods Retrospective study uses prospective inpatients' information. Thirty-day readmissions were deemed potentially avoidable or non-avoidable by a computerized algorithm, and annual rate was reported between 2010 and 2014. Observed rate was compared to expected rate, and medical record review of potentially avoidable readmissions was conducted on data between January and June 2014.

Results During a period of ten semesters, 11,011 stays were screened by the algorithm and a potentially avoidable readmission rate (PAR) of 7% was measured. Despite stable expected rate of $5 \pm 0.5\%$, an increase was noted concerning the observed rate since 2012, with a highest value of 9.4% during the first semester 2014. Medical chart review assessed the 109 patients screened positive for PAR during this period and measured a real rate of 7.8%. The delta was in part due to an underestimated case mix owing to sub-coded comorbidities and not to health care issue.

Conclusions The present study suggests a methodology for practical use of data, allowing a validated quality of care indicator. The trend of the observed PAR rate showed a clear increase, while the expected PAR rate was stable. The analysis emphasized the importance of adequate “coding chain” when such an algorithm is applied. Moreover, additional medical chart review is needed when results deviate from the norm.

Background

Quality control is a key to improve health care and decrease costs. Among other measures, reduced readmission rate is of importance. As Swiss health care system applies DRG-based system for hospital financing since 2012, this country and others as well are concerned by readmission problems. During implementation period, desired DRG effect was observed with a significant decrease in hospital length of stay, as observed in other countries [1, 2]. However, over time higher 90-day readmission rates were also observed, motivating the parallel

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implementation of a systematic monitoring of quality of care delivered [3].

Worldwide, readmission rate is increasingly used as a measure for hospital performance. The USA developed the 3 M Potentially Preventable Readmission Grouping Software on the foundation of the 3 MTM APR-DRG classification system [4], and results are publicly reported [5]. Following the gradual increase in readmission in Switzerland, the indicator of potentially avoidable readmissions (PAR) was introduced as quality measurement by the Swiss National Association for the Development of Quality in Hospitals and Clinics [6] (ANQ). As it is done in the USA, software (SQLape[®]) was exploited in Switzerland to identify potentially avoidable readmissions. PAR is part of a quality strategy that creates the conditions for genuine qualitative competition between health care providers. Several studies have analyzed factors potentially leading to preventable readmission; four principal factors were identified and are recurrent including patient factors, clinical, social and system factors, each of them with a different impact. The two elements with highest preventability are system and clinician factors [7, 8], and ways to improve the observed rates are mainly focused on clinical practice and patients' factors [9].

The aim of the present study was to measure the PAR rate based on routinely coded and administrative data of a visceral surgery department using a validated software (SQLape[®]) and to assess whether there were some quality factors to improve. Furthermore, it was also the demonstration of a practical way to use such a standardized indicator in daily clinical routine.

Methods

We used 30-day PAR rate, which is the proportion of index stays (i.e., eligible discharges) followed by potentially avoidable readmission within 30 days post-hospital discharge. It is an inpatient quality of care indicator tracking the lack of discharge preparation, too early discharge or sub-optimal care and coordination. Number of studies demonstrated that 30-day was an optimal timeline for identifying readmission [10–12]. Worldwide, hospital readmissions within 30 days after inpatient discharge are frequent [13, 14], costly [15] and actionable for improvement [16].

Based on administrative data, coded diagnoses and procedures, readmissions are automatically classified as potentially avoidable or non-avoidable by a computer program (version 2015, Fig. 1) and an observed PAR rate is calculated [17]. SQLape[®] algorithm (acronym for “striving for high quality level and analyzing of patient expenditures”) is a nationwide used software, which was

validated in a previous study [17]. First, foreseen readmissions (mainly programmed surgery) are considered unavoidable (step 1), provided they are not due to iatrogenic complications (step 2). They are also deemed unavoidable if the readmission corresponds to obstetric conditions or transplants (step 3), chemo- or radiotherapy (step 4) or follow-up (mainly rehabilitation, step 5). If the readmission is due to health care complications, it is considered as potentially avoidable (steps 2 and 6). The remaining readmissions are classified as unavoidable if the main diagnosis is not related to a condition during the previous stay (new condition, step 7). It is, however, potentially avoidable if the readmission is due to a previously known condition, except for trauma and diseases difficult to cure (step 8: myelodysplastic syndrome, multiple sclerosis, liver cirrhosis, etc.).

Both sensitivity and specificity reported by the developers reached approximately 96% [18]. It was recommended to compare both observed and expected PAR rate. A national expected rate was calculated by the SQLape[®] prediction model based on the following data: diagnoses, surgical operations, age, gender, hospitalization in the previous 6 months and admission scheduled or not. More than 3.2 million Swiss hospital discharges between 2003 and 2007 were used to calculate the rates of readmissions expected [17]. This predicted rate is then adjusted for each hospital by including the case mix of its eligible discharges [17]. Therefore, if the observed rate was higher than the expected rate, the quality of patients' discharge was questionable [19].

The visceral surgery department of a tertiary academic center is divided in four sub-specialties team, including hepatobiliary and pancreas, colorectal and proctology, upper gastrointestinal and abdominal wall team and a multidisciplinary team including endocrine, melanoma-sarcoma and kidney transplantation. Every semester since 2010, the department received its proper measured PAR rate compared to the expected rate. In 2014, the measured PAR rate was almost twice higher than the expected rate and showed a constant increase over the past years. This needed to be investigated.

Two different datasets were analyzed. The first included all patients hospitalized more than 24 h in the visceral surgery department and discharged alive between January 2010 and November 2014, stratified on PAR versus non-PAR, using SQLape[®] algorithm. Non-PAR included stays without readmission or stays with readmission not fulfilling the condition of PAR. One-day surgery and patients transferred to another hospital were excluded. Finally, 11,011 inpatients were included between January 2010 and November 2014. This dataset gave the trend for readmission during the last 4 years.

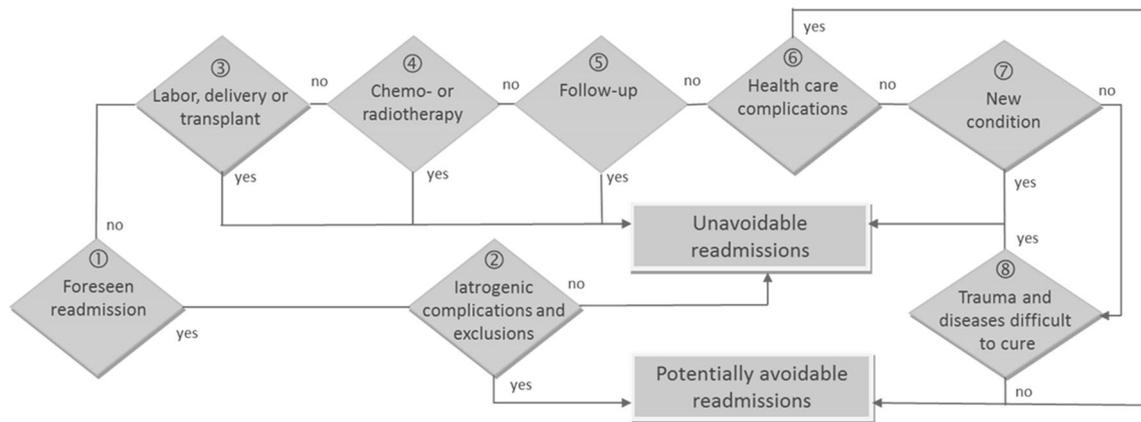


Fig. 1 SQLape[®] algorithm detecting potentially avoidable readmissions [13]

The second dataset included visceral surgery inpatients flagged as PAR using SQLape[®] algorithm between January and June 2014, as well as the following readmission stays. This dataset gave detailed information on cases flagged as PAR during first semester 2014. Files containing PAR ICD-10 coded diagnoses and procedures codes attributed to each index and readmission stays were collected. For this second set of patients, individual medical chart review was performed. Characteristics of admissions were gathered through descriptive analysis, including age and diagnosis at admission, comorbidities, ASA (American Society of Anesthesiology) score, complications during the stay according to the Clavien complication scale [20], body mass index, visceral surgery team in charge of the patient, affiliation (since 2011) to the ERAS[®] protocol [21] and surgical management.

The readmission characteristics collected were the elective or emergent character of readmission, readmission diagnosis with its respective Clavien complication score and the service or team in charge if the patient had returned to the visceral surgery department. At this point, readmissions flagged as PAR by the algorithm but containing clear information of further planned readmission during index stay was excluded.

In order to challenge the administrative data, each administrative patient's file had been compared to its respective medical chart review. Comparable data (simultaneously present in the administrative and chart review database) extracted for index hospitalizations and readmissions were: diagnostics, comorbidities, complications, surgical management or other interventions (interventional radiology and endoscopy) and delays.

A significant difference was noted between the two information sources concerning comorbidities. This observation led to the creation of a working group composed by two surgeons of the visceral surgery department, and two members of the medical direction and coding

personnel of the hospital. The goal was to analyze this delta and to propose improvement solutions.

This study was approved by the local ethics committee.

Results

Among 11,011 eligible hospital stays between 2010 and 2014, 819 (7.4%) were considered PAR by the algorithm. The observed rate varied from a minimum of 4.8% to a maximum of 9.4% during the overall study period, and the respective expected PAR rate was $5 \pm 0.5\%$ (Fig. 2). By summing each semester in order to observe the annual PAR rate, a constant increase since 2010 was observed (Fig. 3). The population of the first semester 2014, corresponding to the highest observed rate, was selected for medical chart review. During the whole semester, 1160 index stays were included and 109 were flagged as PAR. The number of planned readmission erroneously flagged by the algorithm was 18 (15.6%), and all were excluded, leading to a second set with a definitive total of 91 patients. The corrected PAR rate for the first semester 2014 was calculated at 7.8%. Examples of excluded cases were retrograde cholangiopancreatography followed by planned cholecystectomy, emergent colonic stenting followed by planned colectomy or colectomy with confection of protective ileostomy followed by closure (Table 1).

The mean delay between hospital discharge and readmission was 10.6 days. Out of 91 patients, 48 were men. Index stays group of diagnosis and their respective causes of PAR are listed in Table 2. Regarding treatment modalities, 52 patients (57.1%) had surgery during the index stay, 23 (25.3%) had conservative management, 9 (9.9%) had interventional radiology procedure and 7 (7.7%) had gastroenterological procedure. Regarding readmission diagnosis, grade 3 according to Clavien complication score was the most common grade (3a in 11% and 3b in 22%),

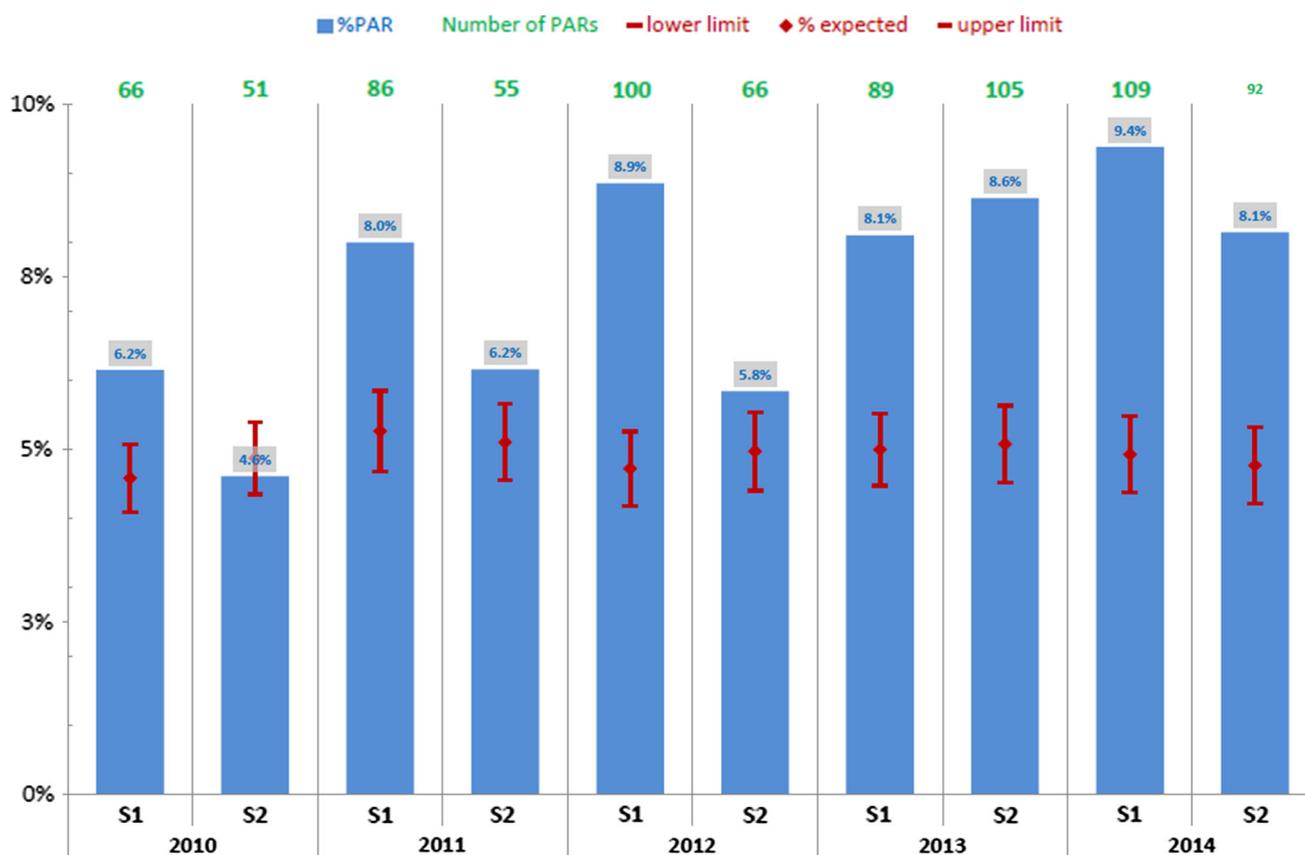


Fig. 2 Observed and expected PAR rate, semestrial evolution

followed by grade 2 (12.1%) and grade 1 (6.6%). There were only 1 case of grade 4b and 2 cases of grade 5.

The most frequent complication leading to PAR was surgical site infection (SSI), in 24 cases (26.4%), following colorectal operation in almost half of the cases. The second and third most common complications leading to PAR were ileus in 13 cases (14.3%) and bleeding in 11 (12.1%). In 11 cases (12.1%), the readmission was linked to a complication that appeared during the index stay and in half of those cases it was due to SSI. Concerning ERAS[®] patients, 16 (17.6%) were flagged as PAR, corresponding to 7.6% of all ERAS[®] patients during this semester ($N = 210$). 14 had a colorectal surgery (6 hemicolectomies, 4 low anterior resections and 4 restoration of digestive continuity after Hartmann's procedure) and 2 had a duodenopancreatectomy with reconstruction.

The mean ASA (American Society of Anesthesiologists) score was 2.1. In our chart review, overweight concerned 30% of PAR patients and obesity 19% (no patients had bypass procedure among index stay). In the administrative data, only 3.3% of the patients were reported obese.

By comparing administrative data used by the computerized algorithm and medical chart review, a significant

difference about the number of comorbidities reported was observed. In the administrative data, an average of 0.8 comorbidity per index stay was noted, while the chart review of the same stays displayed 2.3 comorbidities per stay. The noncoded comorbidities were mainly conditions that may influence the surgical outcome like anticoagulation for arrhythmias or other coagulopathies, chronic renal failure, cardiomyopathy, diabetes mellitus, chronic inflammatory disease needing immunosuppression, alcohol and nicotine abuse.

Discussion

The use of SQLape[®] algorithm allowed to adequately identifying potential avoidable readmissions. The initial observed rate was 9.4% for the first semester of 2014, the highest of the studied period. Systematic medical chart review leads to obtain a corrected PAR rate of 7.8% by excluding false positives, not fulfilling the definition of potentially avoidable readmission (PAR).

Due to the lack of comparison for visceral surgery patients, some studies, however, may provide some



Fig. 3 Observed and expected PAR rate, annual evolution

benchmark. In 2016, a study conducted over 2100 discharges of a level I trauma center general surgery department observed a 30-days readmission rate of 8.2% [22]. Another study including a mix of bariatric procedures, colorectal and hernia procedures as well as hysterectomy, total hip or knee arthroplasty and lower extremity vascular bypass, reported an unplanned readmission rate of 5.7% [23]. Kassin et al. found in their study a readmission rate among general surgery patients of 11.3% [24]. The corrected PAR rate in the present study lies with of 7.8% is in the range of these studies findings.

Some 68.1% of complications leading to PAR were in colorectal and hepatobiliary patients, and SSI was the most frequent complication, followed by ileus and bleeding which is not surprising in advanced digestive surgery. The findings about the causes leading to readmission were comparable to those observed in others studies including visceral surgery patients [23, 24]. Moreover, as in the Merkow study [23], readmissions were associated with new post-discharge complications (86%) and not with exacerbation of prior index hospitalization complications (14%). Of note, ERAS patients were discharged earlier (median 7 days) than same cases before its implementation (median 14.5 days). Although quickly discharged, the 210 patients in ERAS[®] protocol were not at higher risk for PAR (7.6%) compared to non-ERAS[®] patients (7.8%).

The comparison between the chart review and the ICD-10 coded diagnoses and procedures registered in the administrative documentation displayed a significant sub-coding of comorbidities (medical records 2.3 per chart, administrative 0.8). Thanks to the created working group, the delta observed among coded comorbidities was attributed to an incomplete clinical documentation in the patient chart, where comorbidities were only listed without specifying if the condition was handled during the stay or not. This result highlighted important differences between “administrative” and “real treated” patient. As example, a patient with chronic inflammatory disease under immunosuppressive therapy operated for appendicitis and readmitted for SSI. If the actual corticotherapy was not indicated in the medical records or the chronic inflammatory disease not mentioned as active comorbidity and only listed in the discharge letter among other passive previous conditions, the diagnostic was not coded. For this reason, the present study suggests that administrative data in this case and without any further improvement are not reliable for medical evaluation.

Another mechanism hiding information to the algorithm was revealed by the investigation working group. When a maximum sum of codes in term of reimbursement was reached, comorbidities were no further coded, because they did not change the sum of reimbursement. In this case, by

Table 1 False positive (planned readmission) screened as PAR by the algorithm

Admission stay diagnosis	Admission stay procedure	Readmission procedure	(<i>N</i> = 18) <i>n</i> =
Obstructive colon cancer	Stoma/stent	Planned colectomy	2
Hemorrhagic ulcerative colitis	Proctocolectomy with ileostomy	Planned closure of ileostomy	1
Gallstones	ERCP	Planned cholecystectomy	1
Liver metastasis	Portal embolization	Planned hepatectomy	1
Appendicitis (discovery of cancer)	Appendectomy	Planned right colectomy	1
Wound defect (inguinal lymphadenectomy)	Wound debridement	Planned plastic surgery	1
Peri-anal suppurative hydrosadenitis	Large excision	Planned plastic surgery	1
Renal insufficiency	Surgical evaluation	Kidney transplantation	1
Sigmoid volvulus	Endoscopic therapy	Planned sigmoidectomy	1
Rectal cancer	Low anterior resection	Planned closure of ileostomy	1
Colonic fistula	Reported surgery	Planned hemicolectomy	1
Ileus	Conservative management	Planned ureteral catheter change	1
Parastomal hernia	Conservative management	Parastomal hernia repair	1
Diverticulitis (sigmoid)*	Conservative management	Elective coronarography	1
Choledocholithiasis	ERCP reported	Planned ERCP	1
Terminal ileitis of unknown origin	Colonoscopy	Planned balloon colonoscopy	1
Prolapsus (Hartmann colostomy)	Reduction (conservative)	Planned continuity restoration	1
			18

*Linked to a history of pericarditis mentioned in the index stay

failing to code comorbidities, the institution lost no retribution, but the algorithm lost information regarding patients' health condition. If these two mechanisms were present in other hospitals contributing to the calculation of expected PAR rate, it would mean an underestimation. Even if discharge coding accuracy rates are improving [25, 26], some recent papers have warned about the limited value of administrative data alone when measuring patient safety [27]. This seemed obvious but needed to be demonstrated as in the present study. On the other hand, the emergence of high specialized medicine concept (since January 2009 in Switzerland) and its resulting concentration of complex cases in tertiary center could be an additional explanation for the progression of observed PAR since 2010.

Convinced that information systems can improve quality [27] in a cost-effective manner and that this kind of indicator will further remain necessary, a multidisciplinary investigation team (physicians, coding staff and computer scientist) was created to improve the "coding chain". His task was to propose solutions helping hospitals to code comorbidities in an adequate and complete way. A senior physician was appointed to act as referent for the coding staff in each department. Finally, the coding staff was sensitized to the importance of coding all comorbidities listed in the discharge letter, even if it did not increase the reimbursement.

Improved collaboration between administration and medical team needs to be urgently developed as indicators working on routinely coded data have to be increasingly used. The time where medical and administrative staff were not working together (at best) has to be over, now or in the near future, to run adequately a large hospital within the current economic situation in health care. This study also provides, to our knowledge, the first benchmark on 30-day potentially avoidable readmission rate in visceral surgery patients, as well as the first practical way to use a standardized quality of care indicator, opening the way to further international comparison.

This study has some limitations that need to be addressed inherent to its retrospective nature. The results depend mainly from the quality of the coded diagnoses and procedures, and it has to be assumed that some potentially avoidable readmission may have been missed. Moreover, in this study, it was looked at patients' parameters in one area of improvement: the "coding chain". Looking at other parameters like rehabilitation infrastructure access, home support availability and adequate explanation at delivery may probably explain partially the remaining delta between the corrected observed and expected rate. This aspect deserves further analysis outside the scope of the present paper. Known patient factors associated with readmission like higher ASA class, disseminated cancer, presence of ascite, bleeding disorder, renal failure, steroid use, weight loss or malnutrition, dyspnea and patients discharged to a

Table 2 True positive (algorithm’s definition) screened as PAR

Readmission stay group of diagnosis *N* = 91 (%) Ten most frequent reasons for potentially avoidable readmissions after an index stay in the visceral surgery department (for four groups of diagnosis and overall) over a period of 6 months (January to June 2014).

	SSI	Ileus	Bleeding	Relapse of index disease*	Other infection**	Pain	CA progression	Hydration and nutrition	Pulmonary	Other
Overall 91	24 (26.4)	13 (14.3)	11 (12.1)	9 (9.8)	3 (3.3)	5 (5.5)	4 (4.4)	6 (6.6)	4 (4.4)	12 (13.2)
<i>Group colorectal (n = 33)</i>	SSI	Ileus	Bleeding	Other Infection**	Pain	Pulmonary	<i>RI Resection</i>	<i>Anemia</i>	<i>Seroma</i>	
Colorectal 13	11 (33.3)	8 (24.3)	7 (21.2)	2 (6.2)	1 (3.0)	1 (3.0)	1 (3.0)	1 (3.0)	1 (3.0)	
Appendicectomy 5										
Small intestine 8										
Anal 1										
Stoma 5										
CHIP 1										
<i>Group Hepatobiliary (n = 29)</i>	Relapse of index disease	SSI	Hydration and nutrition	CA progression	Pain	Bleeding	Pulmonary	Ileus	<i>Biliary leak</i>	<i>Other***</i>
Gallbladder 8	7 (24.1)	4 (13.8)	4 (13.8)	3 (10.3)	3 (10.3)	2 (6.9)	1 (3.5)	1 (3.5)	1 (3.5)	3 (10.3)
Pancreas 13										
Percutaneous Intervention 6										
<i>Group UGI/abdominal wall (n = 18)</i>	SSI	Ileus	Pulmonary	Hydration and nutrition	Bleeding	Pain	Relapse of index disease	<i>Sepsis</i>	<i>Arterial occlusion</i>	
Esophagus 3	5 (27.7)	4 (22.1)	2 (11.1)	2 (11.1)	1 (5.6)	1 (5.6)	1 (5.6)	1 (5.6)	1 (5.6)	
Stomach 2										
Abdominal wall 12										
Endoscopy 1										
<i>Group endocrine (n = 11)</i>	SSI	<i>Kidney graft biopsy</i>	Relapse of index disease	Other Infection****	Bleeding	CA progression	<i>Kidney graft failure</i>			
Thyroidectomy 1	4 (36.4)	2 (18.1)	1 (9.1)	1 (9.1)	1 (9.1)	1 (9.1)	1 (9.1)			
Kidney graft 5										
Sarcoma 1										
Melanoma 2										
Lymph nodes 2										

*Relapse of cholecystitis while waiting for elective operation (3); relapse of pancreatitis (3); relapse of infected collection (3). **Urinary (2). ***Group hepatobiliary: VTE (1); urinary retention (1); sepsis (1). ****drugs related colitis/fleitis (1). “Appendix” presents the details of pathologies difficult to cure

Table 3 continued

Group UGI/abdominal wall (<i>n</i> = 18)		Stomach 2	Hiatal hernia 1 ^d	Endoscopy 1	Esophageal stricture (scar) 1 ^a	Abdominal wall 12	Ombilical hernia 3 ^d
Esophage 3	Esophageal cancer 3 ^d		Gastric ulcer post gastric bypass 1 ^c				Parietal abcess 3 ^b Ventral hernia 2 ^d Perineal hidradenitis suppurativa 2 ^d Inguinal hernia 2 ^d
Group endocrine (<i>n</i> = 11)							
Kidney graft 5	Diabetic nephropathy 2 ^d	Thyroid 1	Toxic MN goiter 1 ^d	Sarcoma 1	Abdominal metastasis of leg sarcoma 1 ^d	Lymph node 2	Inguinal lymph node biopsy 1 ^d Inguina lymphocele 1 ^d
	HRPK 1 ^d						
	Primary hyalinosi 1 ^d						
	CAKUT ¹ 1 ^d			Melanoma 2	Leg malignant melanoma 2 ^d		

¹Congenital anomalies of the kidney and the urinary tract. ^aGastrointestinal endoscopic procedure (7); ^binterventional radiology procedure (9); ^cconservative management (23); ^dsurgical management (52)

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