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Are temporal trends in retained foreign object rates after surgery in Switzerland impacted by increasing coding intensity? A retrospective analysis of hospital routine data from 2000 to 2019

David Schwappach ,[1] Michael M Havranek[2]

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[1]Institute of Social and Preventive Medicine (ISPM), University of Bern, Bern, Switzerland
[2]Faculty of Health Sciences and Medicine, University of Lucerne, Luzern, Switzerland

Correspondence to
David Schwappach; david.schwappach@unibe.ch

ABSTRACT

Objectives Retained foreign objects (RFOs) after surgery can cause harm to patients and negatively impact clinician and hospital reputation. RFO incidence based on administrative data is used as a metric of patient safety. However, it is unknown how differences in coding intensity across hospitals and years impact the number of reported RFO cases. The objective of this study is to investigate the temporal trend of RFO incidence at a national level and the impact of changes in coding practices across hospitals and years.

Design Retrospective study using administrative hospital data.

Setting and participants 21 805 005 hospitalisations at 354 Swiss acute-care hospital sites

Primary and secondary outcome measures RFO incidence over time, the distribution of RFOs across hospitals and the impact of differences in coding intensity across the hospitals and years.

Results The annual RFO rate more than doubled between 2000 and 2019 (from 4.6 to 11.8 with a peak of 17.0 in 2014) and coincided with increasing coding intensity (mean number of diagnoses: 3.4, SD 2.0 in 2000; 7.40, SD 5.2 in 2019). After adjusting for patient characteristics, two regression models confirmed that coding intensity was a significant predictor of both whether RFO cases were reported at the hospital level (OR: 12.94; 95% CI: 7.38 to 22.68) and the number of reported cases throughout the period at the national level (Incidence Rate Ratio (IRR): 5.95; 95% CI: 1.11 to 31.82).

Conclusions Our results raise concerns about the use of RFO incidence for comparing hospitals, countries and years. Utilising coding indices could be employed to mitigate the effects of coding intensity on RFO rates.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This study utilised hospital administrative data that are commonly employed for various international indicators and comparisons of quality of care.
- ⇒ To attain a more profound understanding, primary and secondary retained foreign object (RFO) diagnoses were separated in the analysis.
- ⇒ Two distinct indices of coding intensity were created to assess how differences in coding practices among hospitals and changes in practices over time impact the RFO incidence.
- ⇒ No clinical data were available to validate coded RFO cases.
- ⇒ The interpretation of this study is limited by the constraints inherent in routinely collected administrative data, namely, that they reflect both, clinical and coding practice, and variations of both of these factors.

INTRODUCTION

Retained foreign objects (RFOs) after surgery are rare and serious patient safety events that can cause significant harm to patients.[1] The reported annual incidence of RFOs ranges from approximately 0.01%–0.02%, or 1 per 5000–10 000 surgeries.[2–5] In a large cohort study, Verma *et al* found that patients with RFOs had a significantly increased risk of sepsis, pulmonary infection, wound infection, longer length of stay and higher costs.[2] RFOs also have the potential to damage a clinician's or hospital's reputation and carry considerable malpractice risk.[6] RFOs have been labelled as 'never events' and are listed on several compilations of serious reportable events, for example, the National Quality Forum List of Serious Reportable Events.[7] In some countries, like the UK and certain US states, RFOs require mandatory reporting to the relevant authorities or regulatory bodies.

Among surgical never events, RFOs belong to the most common category. Of the surgical never events reported to the California Department of Public Health between 2007 and 2017, 94 out of 142 events (66%) were RFOs, followed by wrong site or patient surgery (16% of all events).[8] In the UK, RFOs identified via the never event reporting policy were the second most reported events (28%)

after wrong-site surgery (40%).[9] The national rate of RFOs is also one of the patient safety indicators included in the Organisation for Economic Cooperation and Development (OECD) Healthcare Quality Indicator (HCQI) project, which provides international comparisons of patient safety performance.[10 11] In the most recent OECD report, Switzerland had the highest RFO rate among all OECD countries. In fact, the reported RFO rate in Switzerland in 2019 (12.3 per 100 000 hospital discharges) was 5.9 times higher than that in the USA (2.1 per 100 000 hospital discharges, https://www.oecd-ilibrary.org/sites/b94b4f09-en/index.html?itemId=/content/component/b94b4f09-en#figure-d1e8160).

Some singlecentre and multicentre studies reported a favourable effectiveness of interventions on RFO incidence, like revised counting procedures, the use of technologies such as Radio-Frequency Identification labelling, team training or comprehensive programmes for safer surgery.[12–16] However, it remains unclear whether such studies represent single outstanding efforts or broad and successful implementations of prevention measures in the surgical setting. In other words, little is known about whether the RFO risk for an entire patient population, for example, on a regional or national level, has declined in recent years. The occurrence of RFOs at a single facility is strongly associated with 'surgical productivity' (ie, the number of operating theatres and the number and types of procedures performed) and is largely affected by chance alone.[17] As the frequency of RFOs has been poorly associated with other quality or safety measures at the hospital level, it may not be a robust indicator of surgical safety at a given facility. However, the aggregate RFO incidence may be an important metric of a healthcare system's patient safety performance, in particular for smaller countries. Routinely collected data offer an opportunity to study a nation's RFO risk and the temporal trends of RFO incidence. Such national trends may also allow us to detect any potential impact of changes in surgical practice on RFO incidence (eg, new surgical techniques; new types of intraoperatively of used materials). On the other hand, routinely collected data are subject to coding practices and their potential changes over time, which may limit the validity of this approach.[18] For example, RFOs detected during the hospitalisation of the index procedure are coded as a secondary diagnosis and may thus be more likely to be coded with a general trend towards more secondary diagnoses, for example, due to billing incentives. Thus, changes in the rates of RFO cases may reflect changes in coding intensity rather than 'true' variations in observed RFO cases. The aim of this study was to assess the temporal trend of RFO incidence at the national level. We used routinely collected data from all hospitalisations in Switzerland between 2000 and 2019 and estimated the RFO incidence over time, the distribution of reported RFOs across hospitals and changes in the patterns of involved surgical procedures. In addition, we also examined the impact of changes in coding practices on the number of RFO cases.

METHODS

Data sources

This retrospective study was conducted in Switzerland using a national health administration data set provided by the Swiss Federal Statistical Office (SFSO). The data set[19] contained all inpatient cases treated in Swiss hospitals between 2000 and 2019 with up to 50 diagnosis codes (ICD-10-GM, German modification of the International Classification of Diseases),[20] up to 100 procedure codes (CHOP),[21] the diagnosis-related group (SwissDRG)[22] and other clinically relevant variables such as the admission and discharge conditions as well as demographic information like age and sex. Hospitalisations at psychiatric or rehabilitation facilities as well as infants, children and teenagers under 18 years of age were excluded from the analysis (n=6 394 672). These exclusion criteria were applied to achieve homogeneity in hospitals and cases and to provide results comparable to other indicator-based studies. After these exclusions, data on 21 805 005 hospitalisations at 354 acute care hospital sites were available for analysis. It must be noted that the 354 hospital sites sometimes contained different hospital identifiers for the same facilities if they merged to or separated from previously existing hospitals or hospital groups. Consequently, not all 354 hospital IDs were present throughout the entire 20 year period. In the year 2019, 177 separate hospital sites existed in the data set.

Ethics approval

As the data sets used are completely anonymised, this research does not fall under the scope of the Human Research Act (HRA Section 2,2c) and approval by the ethics committee is not required in Switzerland.[23] Confidentiality and data protection agreements were signed with the Federal Statistical Office.

Variables

Our dependent variable was the number/rate of RFOs defined as cases with either an ICD-10-GM diagnosis code of 'T815' or 'T816'. These cases were our numerator, while the population of all adult acute-stationary cases (with age>18 years) was the denominator. Consistent with the inclusion criteria of RFO rates as part of the Patient Safety Indicator 5 by the Agency for Healthcare Research and Quality (https://qualityindicators.ahrq.gov/measures/PSI_TechSpec), we included both cases defined as surgical and medical in the denominator. We further distinguished between RFOs coded as the main diagnosis and RFOs coded as a secondary diagnosis.

As independent variables, two variables were calculated to reflect coding intensity: the first coding-intensity variable reflects coding practice in a given hospital and year relative to other hospitals in the same year. It was calculated by dividing the number of coded diagnoses per hospitalisation by the average number of coded diagnoses of all hospitalisations with the same main diagnosis (across all hospitals) and summing up the resulting values across all hospitalisations of a given hospital. This way, we were able to define a single value for the coding intensity of each hospital that was centred around 1.0. This was done separately for each year and will subsequently be referred to as the coding-intensity index per hospital. In contrast, the second coding-intensity variable represents national coding practices and its variation over time. It was calculated by dividing the number of coded diagnoses per hospitalisation by the average number of coded diagnoses for all hospitalisations with the same main diagnosis (across all hospitals and all years) and summing up the resulting values across all hospitalisations of ALL hospitals in a given year. This way, we were able to define a single value for the coding intensity of ALL hospitals in a particular year (which was also centred around 1.0 across the years). This variable was thus calculated to compare coding differences over the years while taking into account changes in case mix and will in the following be referred to as the coding-intensity index per year. As covariates, we used the mean age of patients, the percentage of emergency admissions, the percentage of surgical cases and the type of the hospitals (university and large cantonal hospitals vs general hospitals vs specialised surgical hospitals vs other specialised hospitals) in our analyses.

Statistical analysis

Details of coded RFO cases and changes in patterns of involved surgical procedures were analysed using descriptive statistics. The incidence rates of RFOs per year were calculated for both RFOs coded as main and secondary diagnoses. A Jonckheere-Terpstra test was used to determine whether there was a trend in RFO rates over time. The mean coding-intensity indices of hospitals that coded secondary RFO diagnoses versus those that did not were compared across the entire period. A panel-type random-effects regression model was estimated with the coding-intensity index per hospital as the outcome and the reporting of any secondary RFO diagnoses (binary, yes vs no) as the exclusive predictor variable. The resulting mean coding-intensity indices for hospitals with versus without reported RFO cases account for clustering of hospitals. To assess the impact of the hospital level coding-intensity index on the likelihood that a hospital would report at least one secondary RFO case (after adjusting for hospital case mix), a panel-type random-effects logit model with the hospital as the unit of observation and the year as the time variable were estimated. Robust variance estimators were used. To investigate the impact of changes in national coding practices on the RFO incidence rate over time, a Poisson regression model was estimated with the secondary RFO incidence rate as the outcome and coding-intensity index per year and several covariates as predictor variables. Robust variance estimators were used. Results were considered significant where p<0.05.

Patient and public involvement

None.

RESULTS

During 2000–2019, there were 2492 RFO cases coded in Swiss hospitals, of which 645 had a main and 1847 a secondary RFO diagnosis code. The mean RFO rate per 100 000 hospitalisations over the 20 year period was 11.43 (95% CI: 10.98 to 11.89). Details on the coded cases are provided in table 1.

Details of the most common procedures

Among the patients with a secondary RFO diagnosis, the most common procedures coded as a main procedure were repairs and plastic operations on joint structures and operations on skin and subcutaneous tissues (see online supplemental table 1). There were minor changes in the most frequent procedures among secondary RFO diagnoses over the two decades. For 345 of the 645 patients with a main RFO diagnosis, data on prior hospitalisations were available. Among these patients, the most common procedures preceding the hospitalisation with the RFO main diagnosis are provided in online supplemental table 2. Among the patients with an RFO main diagnosis for whom data were available on previous procedures, 33% (113/345) had one or more procedures at a hospital other than the hospital in question, which subsequently coded the RFO main diagnosis.

Temporal trends

The annual RFO rate more than doubled between 2000 and 2019, with a peak in 2014 (see online supplemental figure 1). The changes in annual rates were mainly driven by RFO secondary diagnoses (see figure 1), whereas RFO main diagnoses seem to have plateaued in 2009. A test for trend showed significant results for annual secondary RFO diagnoses (Jonckheere-Terpstra, p<0.001), but not for main diagnoses (Jonckheere-Terpstra, p=0.069). The relation between primary and secondary RFO diagnoses changed substantially from 2000 to 2019: the fraction of secondary diagnoses increased from 49% to 83% (see online supplemental figure 2).

Hospitals reporting RFOs

A large fraction of reported RFO cases were clustered in a few hospitals (see table 2). Three hospitals accounting together for 8.53% of hospitalisations reported 15.13% of all RFO cases between 2000 and 2019. Of the 2492 RFO cases, 1260 (50.56%) were reported by 20 of the 354 hospital sites (5.65%), representing 35.28% of all hospitalisations throughout the 20 year period. During the same time frame, 173 hospital sites (48.87%) did not code a single RFO case. The hospital specific RFO rates of hospitals reporting at least one RFO case in the 20 year period ranged from between 1.30/100 000 (95% CI: 0.16 to 4.68) and 114.29/100 000 hospitalisations (95% CI: 2.89 to 635.10). Among university hospitals, the RFO rate ranged from between 11.25/100 000 (95% CI: 8.88 to 14.06) and 21.76/100 000 hospitalisations (95% CI: 18.42 to 25.52).

Table 1 Details of the main and secondary RFO cases

	Type of coded RFO		
	Main diagnosis	Secondary diagnosis	Total
Frequency, n (%)	645 (25.88)	1847 (74.12)	2492 (100)
Sex, male %	43.26	48.78	47.35
Mean age, years (SD)	53.74 (17.17)	57.80 (18.07)	56.75 (17.92)
Type of admission, %			
Emergency	26.51	32.76	31.14
Elective	72.40	65.30	67.13
Other/unknown	1.09	1.95	1.73
Type of hospital			
Major cantonal	36.12	45.37	42.98
University	28.06	22.04	23.60
Large regional	14.11	13.59	13.72
Medium regional	12.56	11.42	11.72
Specialised surgery	5.27	4.60	4.78
Small regional	3.72	2.27	2.65
Other	0.16	0.70	0.56
Mean length of stay, days (SD)	5.03 (9.01)	13.09 (20.56)	11.01 (18.62)

RFO, retained foreign object.

Impact of coding intensity on secondary RFO diagnoses

The coding-intensity indices of hospitals that coded at least one secondary RFO in a given year were significantly higher compared with those that did not report any secondary RFO in that year (mean 1.04 vs 0.90, p<0.001). In other words, hospitals with at least one secondary RFO coded an above average number of diagnoses (even if differences in case-mix and clustering within hospitals are

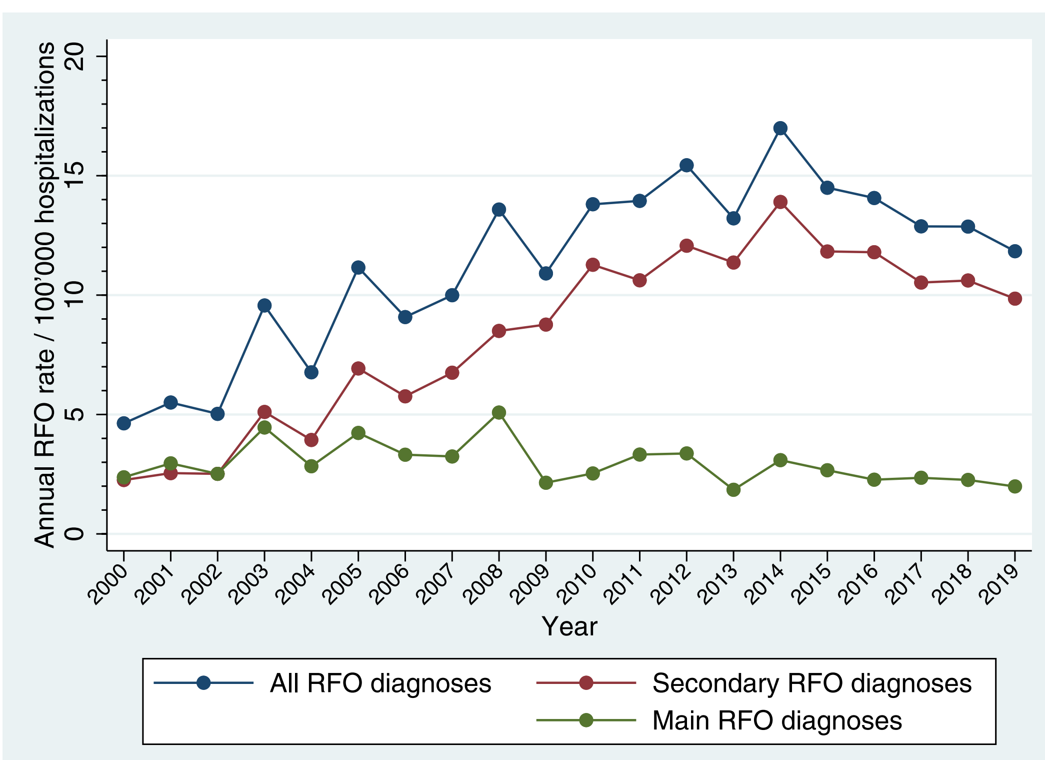

Figure 1 Annual RFO rates per 100 000 hospitalisations by year and type of RFO diagnosis (main vs secondary). RFO, retained foreign object.

Table 2 Cumulated distribution of RFO cases in hospitals

Cumulated N of any coded RFO	Cumulated % of any coded RFO	Cumulated N of hospitalisations	Cumulated % of hospitalisations	Cumulated N of hospitals	Cumulated % of hospitals
377	15.13	1 859 597	8.53	3	0.85
1260	50.56	7 693 161	35.28	20	5.65
1872	75.12	12 774 830	58.59	51	14.41
2492	100.00	20 409 660	93.60	181	51.12
2492	100.00	21 805 004	100.00	354	100.00

N, number; RFO, retained foreign object.

taken into account, see Methods section). After adjusting for the annual patient characteristics of hospitals, the coding-intensity index was also a significant predictor of whether a secondary RFO case (see table 3) was reported at the hospital level. The intraclass correlation (rho) shows that a substantial fraction of the variance (23%) is explained by differences across hospitals.

At the national level, the rising rates of reported secondary RFO cases (see figure 1) coincided with an increasing coding intensity throughout the same period. While the mean number of coded diagnoses weighted and averaged over all diagnoses was 3.4 (SD 2.0) in 2000, it had increased to 7.40 (SD 5.2) in 2019. The mean coding-intensity index per year was 0.73 (SD 0.4) in 2000 and 1.3 in 2019 (SD 0.8), respectively. That is, the mean number of diagnoses coded for any given main diagnosis relative to the long-term average was significantly lower in 2000 compared with 2019 (p<0.001, even after adjusting for the case mix of the national sample over the relevant period, see Methods section).

The regression model confirms increasing rates of secondary RFO diagnoses in the last 20 years, even after adjusting for variations in patient case mix and hospital mix (see table 4). The joint effect of the coding-intensity variable and its interaction with hospital type is substantial and significant (p=0.002). To illustrate the marginal effect of changes in coding intensity over the years, the number of events that could be attributed to changes in coding intensity were predicted while keeping all the other variables at their observed annual values: if coding intensity had not increased since 2000, 1458 secondary RFO events would have been expected, rather than the 1847 observed. On the contrary, applying the more extensive coding intensity of 2019 to the entire period predicts a total of 2536 events. The simulated overall incidence rates per 100 000 hospitalisations over the entire period

Table 3 Random-effects logistic regression model of hospitals' coding any secondary RFO diagnosis (yes vs no) during 2000–2019 as outcome, with robust variance estimators

	OR	95% CI	P value
Coding-intensity index per hospital	12.94	(7.38 to s22.68)	≤0.0001
% Emergency admissions	1.02	(1.01 to 1.03)	0.0001
% Surgical cases	1.04	(1.03 to 1.05)	≤0.0001
Mean patient age, years	1.01	(0.99 to 1.04)	0.2363
Type of hospital (to base: general hospital)			
University and large cantonal hospitals	7.23	(4.81 to 10.86)	≤0.0001
Specialised hospital, surgery	0.20	(0.08 to 0.48)	0.0003
Specialised hospital, other	0.19	(0.09 to 0.39)	≤0.0001
Constant	0.00	(0.00 to 0.00)	≤0.0001
lnsig2u	–0.00	(–0.42 to 0.42)	
sigma_u	1.00	(0.81 to 1.23)	
rho	0.23	(0.17 to 0.32)	≤0.0001
n, clusters (hospitals)	354		
N, observations (hospitals x years)	4123		
Model Wald test	≤0.0001		
Pseudo R^2	0.30		

RFO, retained foreign object; RFS, retained foreign object.

Table 4 Poisson regression model of the secondary RFO incidence rate as outcome, with robust variance estimators

Independent variables	Incidence rate ratio	95% CI	P value
Year (to base: 2000)			
2001	1.07	(0.52 to 2.22)	0.8533
2002	1.02	(0.57 to 1.83)	0.9399
2003	2.06	(1.25 to 3.38)	0.0045
2004	1.5	(0.86 to 2.61)	0.1507
2005	2.63	(1.48 to 4.67)	0.0009
2006	2.12	(1.10 to 4.06)	0.0241
2007	2.51	(1.40 to 4.52)	0.0021
2008	3.27	(1.90 to 5.64)	≤0.0001
2009	3.37	(1.94 to 5.86)	≤0.0001
2010	4.25	(2.33 to 7.75)	≤0.0001
2011	3.93	(2.10 to 7.33)	≤0.0001
2012	4.15	(2.11 to 8.16)	≤0.0001
2013	3.68	(1.72 to 7.89)	0.0008
2014	4.4	(2.00 to 9.71)	0.0002
2015	3.78	(1.74 to 8.19)	0.0008
2016	3.8	(1.74 to 8.27)	0.0008
2017	3.43	(1.52 to 7.76)	0.0031
2018	3.53	(1.48 to 8.43)	0.0045
2019	3.34	(1.35 to 8.24)	0.009
Mean patient age, years	0.92	(0.89 to 0.96)	≤0.0001
Emergency admissions	0.83	(0.72 to 0.96)	0.01
Surgical cases	3.5	(2.91 to 4.20)	≤0.0001
Type of hospital (to base: general hospital)			
University and large cantonal hospital	4.94	(2.39 to 10.20)	≤0.0001
Specialised hospital, surgery	0.24	(0.03 to 2.23)	0.211
Specialised hospital, other	0.4	(0.04 to 3.58)	0.4089
Coding-intensity index per year	5.95	(1.11 to 31.82)	0.037
Interaction type of hospital x coding-intensity index (to base: general hospital)			
University and large cantonal hospital	0.28	(0.13 to 0.58)	0.0006
Specialised hospital, surgery	2.1	(0.25 to 17.45)	0.4934
Specialised hospital, other	1.16	(0.16 to 8.49)	0.886
Constant	0	(0.00 to 0.00)	≤0.0001
N, observations (groups determined by depvars)	320		
Deviance goodness-of-fit	0.71		
Model Wald test	≤0.0001		
Pseudo R^2	0.54		

RFO, retained foreign object.

would be 6.69 according to the coding intensity of the year 2000 or 11.63 with that of 2019, rather than the observed incidence of 8.47.

DISCUSSION

Over the past 20 years, the incidence of coded RFOs has increased in Switzerland with some stabilisation over the last 5 years. The trend was mainly driven by an increase in secondary RFO diagnoses. The 20 year average of 11.43 cases per 100 000 hospitalisations is close to the 12.4/100 000 hospitalisations reported by Chen *et al* for 2003–2007 using a similar methodology.[24] Contrary to prior reports, the procedures most commonly involved in secondary RFO cases in our study were related to orthopaedic rather than visceral, thoracic or gynaecological procedures.[2 25 26] Since this finding was stable over the 20 year period, in-depth analyses of these cases using medical chart review would be valuable to investigate the characteristics, severity, and causes of the incidents.

A large fraction of RFO cases in our data concentrated in relatively few hospitals. These hospitals were both characterised by the provision of 'higher risk surgery', like university hospitals, and also coded above average numbers of secondary diagnoses. Thus, under coding by other hospitals is likely and the 'true' national RFO rate could even be substantially higher than that reported, as suggested by our simulation. The more frequent coding of secondary diagnoses that fall under 'comorbidities and complications' (including RFOs) can increase DRG-based reimbursements in Switzerland and thus economic optimisation strategies may explain variations in secondary diagnosis coding practices. Interestingly, RFOs were only reimbursement relevant in Switzerland until 2014. After 2014, RFOs were no longer reimbursed in addition to the other present diagnoses and procedures, which may explain why the coding of secondary RFO diagnoses peaked in 2014 and remained constant thereafter.

In our analyses, secondary diagnosis coding intensity was related to RFO coding at the hospital level and at the national level over time. Both observations question the use of RFO incidence for comparison between hospitals (even if otherwise similar) and over time. If such substantial differences in coding intensity can be observed within one country, they are likely to explain variations between countries as well, raising doubts about international comparisons as published, for example, by the OECD. In 2013, the preliminary set of quality indicators for international comparisons was evaluated in a Delphi consensus approach of the OECD HCQI expert group. The indicator 'retained surgical item or unretrieved device fragment (adult)' obtained the highest rating in terms of being 'internationally feasible' among all the evaluated indicators and received the maximum achievable rating for recommendation to keep as quality indicator.[10] However, in light of our results, we expect the RFO incidence to both be affected by national case mix and surgical productivity, practices and performance, and also by coding practices completely unrelated to surgical care. To mitigate this problem, our suggested coding indices could be used as a simple approach to evaluate coding practices prior to comparing RFO incidence rates. Further, specific rules and regulation for coding could enhance and homogenise coding practices and decrease variation between hospitals.

The interpretation of our results is limited by the constraints inherent in routinely collected administrative data. While it seems very plausible that variations in RFO incidence rates are affected by the changing of coding practices, these two developments could coexist independently of each other. Another limitation relates to the linkage of main RFO diagnoses to preceding procedures based on time and plausibility. As we had no access to clinical data, the causal relationship remains unverified. Some RFOs are detected with substantial time lag[27 28] and could thus very well be attributed to the wrong prior procedure. Finally, being restricted to administrative data, we could not identify false-positive cases, that is, patients with neither main nor secondary 'true' RFO incidents. In data from the Veterans Health Administration 2003–2007, 55% of cases with an RFO ICD code were false-positives after medical record review.[24] Of these, the majority were present on admission RFOs, purposely included in our study as main RFO diagnoses. However, for 24% of cases identified in the administrative data, there was no indication of any accidental foreign body event in the medical record, that is, they were 'true false-positives'. A recent validation study conducted in Switzerland reports similar results for RFOs (51% false-positives, of which 58% were present on admission; manuscript in preparation).

In Switzerland, an average of 125 RFO cases have been documented and coded annually over the past 20 years. Whether and how these cases have been analysed for learning and prevention purposes remains unknown. In a recent survey study among Swiss hospital risk managers, 44% were aware of at least one RFO event in their hospital but only 55% believed that their hospital could provide an accurate count of RFO incidents.[29] Risk managers were also not regularly and systematically involved in analyses of such events. As RFOs are rare, it could be possible to automatically notify hospitals' risk management of coded, secondary RFO cases at their institutions. This could ensure that the cases are investigated together with the involved surgical staff and prevention strategies derived.

Our study revealed an increasing incidence of RFOs over the last 20 years and seem to have recently plateaued. Since it can be expected that the effect of coding intensity will gradually wash out in the long-term, future analyses will be required to confirm the stabilisation of RFO incidents. Taken together, our results raise concerns about the use of RFO rates for comparisons between hospitals, countries and over time. However, our approach of utilising coding indices would pose one possible strategy to mitigate the problematic impact of coding intensity on RFO rates.

Correction notice This article has been corrected since it was first published. The affiliations of the authors has been switched.

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ORCID iD

David Schwappach http://orcid.org/0000-0001-8668-3065

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