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POSTOPERATIVE WOUND DEHISCENCE AFTER LAPAROTOMY: A USEFUL HEALTH CARE QUALITY INDICATOR? A COHORT STUDY BASED ON NORWEGIAN HOSPITAL ADMINISTRATIVE DATA

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ABSTRACT

Objectives

Postoperative wound dehiscence (PWD) is a serious complication to laparotomy, leading to higher mortality, readmissions and cost. The aims of the present study are to investigate whether risk adjusted PWD rates could reliably differentiate between Norwegian hospitals, and whether PWD rates were associated with hospital characteristics such as hospital type and laparotomy volume.

Design

Observational study using patient administrative data from all Norwegian hospitals, obtained from the Norwegian Patient Registry, for the period 2011-2015, and linked using the unique person identification number.

Participants

All patients undergoing laparotomy, at least 15 years old, with length of stay at least two days, and no diagnosis code for immunocompromised state or relating to pregnancy, childbirth and puerperium. The final data set comprised 69 424 patients with 80 279 laparotomy episodes from 47 hospitals.

Outcomes

The outcome was wound dehiscence, identified by the presence of a wound reclosure code, risk adjusted for patient characteristics and operation type.

Results

The final data set comprised 1 487 wound dehiscences. Crude PWD rates varied from 0% to 5.1% among hospitals, with an overall rate of 1.85%. Three hospitals with statistically significantly higher

PWD than average were identified. Hospital volume was not associated with PWD rate, except that hospitals with very few laparotomies had lower PWD rates.

Conclusions

Among Norwegian hospitals, there is considerable variation in PWD rate that cannot be explained by operation type, age or comorbidity. This warrants further investigation into possible causes, such as surgical technique, perioperative procedures or handling of complications, e.g. wound infections. The risk adjusted PWD rate after laparotomy is a candidate quality indicator for Norwegian hospitals.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- Includes all laparotomies performed in the nation over a five-year period, with patients followed across hospitals
- Extends previous studies to a new health system and a new coding system
- The statistical analysis uses methods for low event rates, avoiding asymptotic approximation
- Results may be subject to coding inaccuracy and incompleteness, as well as selection effects
- There were no data for surgical technique, as well as some relevant comorbidities.

INTRODUCTION

The past decades have seen a major growth in initiatives for measuring, monitoring, and improving the quality of health care services. Quality indicators are regularly published in many health care systems. Performance of health care systems is also compared across nations, for instance in the OECD Health Care Quality and Outcomes (HCQO) initiative, which Norway is a part of.[1 2] Norway has a national quality indicator system for monitoring and comparing hospital performance, however, not all areas of hospital performance are covered by existing national quality indicators. While there are quality indicators for outcomes such as mortality and process measures such as waiting times,

complications following hospital care is less explored, which is especially relevant following surgical procedures.

Postoperative wound dehiscence (PWD) rates after open abdominal surgery (laparotomies) was introduced as a patient safety indicator in the United States and later as a quality indicator by OECD.[3-6] Norway reported the second highest numbers for 2014-2015, with a PWD rate of 1.02%. The overall range was 0.055% to 1.05% .[5] Neighbouring Sweden, with comparable population health and health care, reported 0.30%. Moreover, a recent study comparing adverse events in Norway and Sweden found significantly higher adverse event rates of surgical complications in Norwegian hospitals, compared to Swedish hospitals.[7]

PWD is a serious complication that leads to higher mortality rates, higher implicit, explicit and social costs as well as increased readmission rates.[8 9] The PWD rate has been studied elsewhere as a quality indicator for hospitals, and found to have a high positive predictive value.[10 11] There are typically few wound dehiscence events per hospital, making it more difficult to identify outlier hospitals for quality improvement.

Previous research has identified a number of risk factors for PWD. Examples of such factors are: (I) patient related variables: smoking[12] and obesity[13]; (II) procedure related factors: operation type[9 14], type of incision and closure[15-17] and length of operation time[18]; (III) postoperative parameters: clean wound classification[18] and coughing[9]; (IV) operative scenario: surgical team and nursing staff[13], etc.

The objectives of this study are to investigate the incidence of PWD after laparotomy at Norwegian hospitals, and the potential usefulness of a PWD indicator for the Norwegian health care system, computed from patient administrative data. More specifically we aimed at 1) investigate the possibility to identify hospitals with higher or lower laparotomy PWD rate than average, 2) to study

the variability of the PWD rate among hospitals and its relation to hospital type and laparotomy volume.

MATERIAL AND METHODS

Patient administrative data from all Norwegian hospitals were provided by the Norwegian Patient Registry (NPR) for the period 2011-2015.[19] This comprised individual patient data from all department stays: type of admission (acute or elective), primary and secondary diagnosis codes according to the Norwegian version[20] of ICD-10, surgical and medical procedures, age, gender, date and time of ward admission and discharge. Surgical procedures and operations are coded according to the Norwegian version of the NOMESCO Classification of Surgical Procedures (NCSP-N).[21] Procedure time and date were not available. It was therefore not possible to exclude reclosures of wounds occurring before or on the same day as laparotomies within the same episode, as requested in the OECD indicator specification. The NPR data files were checked for missing values and inconsistencies between variables, such as date and time of discharge before admission, valid ICD-10 code etc.

All permanent residents in Norway have a Personal Identification Number (PIN). NPR prepared an encrypted PIN for all patients with a valid PIN, allowing tracking of patients over time and between hospitals. The data were linked with the National Registry to provide data of death (when applicable), using the PIN.

Ward admissions for each patient, at more than one hospital in case of transfers, were linked into episodes of care when less than eight hours elapsed from time of discharge to the next ward admission.[22] Wound dehiscence was defined as the occurrence of a code for a reclosure operation. Laparotomies and wound reclosure operations were identified according to procedure codes. Each reclosure episode was linked to the laparotomy episode immediately preceding or coinciding with it. Reclosure episodes with no preceding laparotomy episode within 30 days, as well as laparotomy or

reclosure episodes following a reclosure episode within 30 days, were excluded. Note that the linking of laparotomies and reclosures was not part of the original OECD specification, but is required in order to attribute PWD to hospitals and to enable risk adjustment. Laparotomy episodes (and any linked reclosure episode) were excluded if a diagnosis code for immunosuppression or relating to pregnancy, childbirth and puerperium was present, if the length of stay was less than two days, or if the patient's age was less than 15 years. Hospitals with less than 10 laparotomies over the five-year period were excluded. The hospitals belonged to one of three types: regional, large with acute function and small with acute function. For details of codes used, see the online supplement.

The Charlson comorbidities were determined from previous admissions three years prior to, but not including the current episode of care.[22-24] Diagnoses were grouped according to the Clinical Condition Summary system (CCS), adapted to the Norwegian version of ICD-10.[25]

Statistical methods

Risk adjusted probabilities for a laparotomy episode resulting in a reclosure operation were estimated by bias corrected logistic regression.[26] The following case-mix variables were included: age (modelled by natural splines), gender, indicators for the individual Charlson comorbidities, number of previous hospital admissions two years prior to current admission, and whether the episode was acute or elective. A linear trend in admission year was also included. Based on previous studies of risk factors [9 14], procedures were categorized into 13 types, according to the body system or organ involved. The effects of operation types were normalized to have zero sum. The final model was fit by stepwise regression with the BIC criterion, including two-way interactions.

To identify outlier hospitals, i.e. those with high or low risk adjusted PWD probabilities, estimated hospital effects were compared to a reference value, defined as the 25% trimmed mean of the hospital effects on the logistic scale.[27] As some hospitals reported zero reclosures, ordinary maximum likelihood estimates of the model parameters do not exist, due to separation [28], and the estimated

variances of the fitted parameters, based on their asymptotic distribution, become unreliable. The comparison used an exact test based on the Poisson binomial distribution for the number of PWDs per hospital, using the estimated probabilities for each case, together with parametric bootstrapping to account for the estimation uncertainty in the model parameters. Tests for significance were corrected for multiple comparisons using the Guo-Romano method [29], and outlier status assigned according to the false discovery rate (FDR). An FDR not exceeding 5% was regarded as significant. For sensitivity analysis, two alternative risk adjustment models were tested, with either a four-category grouping of procedures or with diagnosis categories instead of the 13-category procedure grouping. In addition, a model with the four Norwegian hospital regions was also estimated. Hospital volume, modelled by splines, was tested for inclusion in the model.

Finally, the hospital specific effects were modelled as a mixture of two normal distributions. The expectation-maximization (EM) algorithm was used, taking into account the estimation variances. The mixture model yielded estimates of the quartiles of the hospital odds ratios and the scaled interquartile range (normalized by dividing by 1.349, to give the standard deviation in the case of a normal distribution) was computed as a measure of spread among hospitals. Bootstrapping of the mixture model was used to find a 95% confidence interval for the scaled interquartile range.

Patient and Public Involvement

Patients were not involved in this study. The policy of the Norwegian Institute of Public health to publish hospital quality indicators, when they have been successfully validated.

RESULTS

The initial data set comprised 98 782 episodes with laparotomy and 1 909 with a reclosure operation. After restricting data to reclosures paired with a laparotomy within 30 days, 1 487 reclosures remained. After exclusions for pregnancy, childbirth and puerperium or immunocompromised state, age and LOS, 80 469 laparotomies remained (no reclosures were excluded). Lastly, hospitals with less

than 10 laparotomies were excluded, yielding a final data set with 69 424 patients, 80 279 laparotomies from 47 hospitals. Descriptive statistics for the dataset are shown in Table 1.

Table 1. Descriptive statistics

	PWD	**No PWD**
Age, median (quartiles)	69 (61 - 78)	65 (51 - 74)
Females, %	35	55
Acute primary episode, %	44	33
PWD as primary diagnosis, reclosure episode, %	3	—
Hospital type		
Regional	546	28 274
Large, with acute function	819	42 271
Small, with acute function	122	8 247
Diabetes with chronic complications	1.3	1.1
Hemiplegia or paraplegia	1.1	0.5
Chronic pulmonary disease	13.2	6.5
Renal disease	4.4	3.5
30 day mortality (primary episode)	4.5	3.3
LOS days primary episode, median (quartiles)	18.8 (11.2 - 29.1)	7.2 (4.3 - 12.3)
Percentage of reoperations in same episode	82	—

From 2011 to 2015, the annual volume of laparotomies decreased somewhat, from 17 468 to 14 728, while the proportion of acute laparotomies remained stable at around 33%.

The overall rate of PWD for the five-year period was 1.8%. Crude PWD rates varied from 0% to 5.1% among hospitals. After risk adjustment, the range was 0.1% - 5.2% . Table 2 shows the odds ratios of the final logistic regression model. The model showed good fit according to the modified Hosmer-Lemeshow test[30] (p=0.8) and good predictive ability, with an area under the operating characteristic (AUC) of 0.73.

Table 2. Final model for risk adjustment

Variable	Odds ratio (95% confidence interval)
Year of admission	0.93 (0.90,0.97)
Spline function 1	4.07 (2.42,6.85)
Spline function 2	3.63 (2.45,5.36)
Spline function 3	6.17 (1.85,20.55)
Spline function 4	2.61 (1.26,5.43)
Female	1
Male	2.36 (2.10,2.64)
Elective	1
Acute	1.36 (1.22,1.52)
Chronic Pulmonary disease	1.72 (1.48,2.01)
Operation type	
Several organs	2.15 (1.69,2.75)
Hernia	2.80 (2.16,3.64)
Thoracoabdominal aorta	1.58 (0.58,4.31)
Abdominal wall	0.66 (0.21,2.10)
Gastrointestinal tract	2.22 (1.84,2.67)
Liver	1.27 (0.81,2.00)
Biliary tract	0.24 (0.12,0.48)
Pancreas	0.76 (0.40,1.46)
Spleen	0.99 (0.37,2.67)
Other digestive system	1.95 (1.50,2.53)
Kidney	0.22 (0.11,0.45)
Other urinary and male genital organs	0.42 (0.31,0.58)
Female genital organs	1.39 (1.02,1.89)
Peripheral vessels	1.23 (0.94,1.60)
Hospital	
Scaled interquartile range	0.30 (0.23,0.34)

In Figure 1, risk-adjusted PWD rates are shown for each hospital, plotted versus laparotomy volume and hospital type.

After significance testing, we identified three hospitals with higher PWD and none with lower PWD than average, when correcting for multiple testing. Without multiple test correction, one additional hospital with high PWD was found.

In the alternative model including volume, the PWD increased with yearly laparotomy volume from a very low level up to 120 laparotomies per year, after which it remained fairly constant, see Figure 1. The effect of volume was significant ($p<0.001$). Hospital type coincided almost completely with a grouping of hospitals by volume, and was therefore not tested separately. There was significant variation among regions, with the Northern region having the highest and the South-Eastern region the lowest rates (data not shown). Using diagnosis categories or aggregated operation type as risk adjustment variables resulted in very small changes in risk adjusted PWD rates.

Discussion

We have studied a quality indicator for wound dehiscence after laparotomy, based on the OECD specification, that discriminated between Norwegian hospitals. The indicator was risk adjusted for differences in age, gender, comorbidity and type of surgery, and showed little sensitivity to changes in the set of risk adjustment variables. The overall PWD rate was 1.8%. After risk adjustment, the hospitals' PWD rate varied between 0.1% and 5.2%. Laparotomy volume and type of hospital had little effect on the PWD rate, except for hospitals with very low volume. Age, male gender, chronic pulmonary disease, and emergency laparotomy were all significant risk factors for PWD. There were significant PWD differences according to the organ system targeted. The overall rate of PWD showed a small but statistically significant decline over the observation period 2011-2015. The relatively large variation of PWD rates between hospitals after correction for patient characteristics and operation type, indicates possible variation in the quality of healthcare in different hospitals. This may be due to variation in surgical technique and perioperative care, as well as the handling of postoperative complications, such as wound infection, which is known to be a risk factor for PWD.[14] We found PWD

rates well within the range reported in international studies.[9 13 14 18 31-33] Also, the risk factors identified are in accordance with previous studies, albeit limited to administrative data. Laparotomy volume has negligible effect apart from the few hospitals with very low volume. The effect is likely a result of differences in types of operations performed at these hospitals, compared to the other hospitals.

Our study is based on complete data from all Norwegian hospitals performing laparotomies. To the best of our knowledge, no similar study has been performed. NPR, the data source, has been validated for several disease categories[34-37] and has a very high degree of completeness. It was possible to track patients during transfers and reoperations at different hospitals.

There is regional variation in the prevalence of smoking and obesity in Norway which could cause some PWD variation among hospitals. [38] Obesity is more prevalent in Northern Norway, where PWD rates are somewhat higher. However, in other regions where obesity is less prevalent, the rates are similar. There is no consistent correspondence between the known variation in smoking among counties and PWD rates. Some surgical procedures are performed only at regional hospitals, and it is therefore possible that selection effects are present. In that case, one would expect larger changes in PWD rates after risk adjustment for operation type, which was not found. One potential source of error in our study is the completeness and correctness of coding in the NPR, particularly the coding of reclosure operations. The risk adjustment depends on data from previous hospitalization and may not capture all comorbidities. Moreover, selection effects cannot not be ruled out. Differing policies for operations on patients with known risk factors, e.g. obesity or smoking, would likely cause variation in PWD rates. No attempt was made to identify main operation or operation intent, as this would require a classification effort outside the scope of the present study. There could be a residual imbalance in case mix, affecting PWD through e.g. operation duration, which is a known risk factor. The observed effect of laparotomy volume is likely a result of differences in types of operations performed at the hospitals with very low volume, compared to the other hospitals.

Previous studies have shown that the quality indicator has high positive predictive value, but only moderate sensitivity.[10] Since we have used specific wound reclosure codes, similar to those used in previous studies, we expect a high positive predictive value in Norway as well. Conceivably, the sensitivity depends on the coding system, in particular the various alternative codes related to complications. Sensitivity in Norway may thus differ from that of other healthcare systems.

Conclusions

Among Norwegian hospitals, there is a significant variation in PWD rate that cannot be explained by operation type, age or comorbidity. This warrants further investigation into possible causes, such as surgical technique, perioperative procedures or handling of complications, e.g. wound infections. The risk adjusted PWD rate after laparotomy is a candidate for use as a quality indicator for Norwegian hospitals, and will make it possible to identify hospitals with apparent quality problems. To achieve sufficient discrimination, however, five-year data are desirable, making it more difficult to monitor changes in hospital performance resulting from quality improvement efforts. It lies outside the scope of the present study to perform a comprehensive validation of the PWD rate as a quality indicator suitable for public reporting. There are uncertainties and potential biases in the indicator, implying that it must be regarded as a signal for follow-up within hospitals, rather than giving a final verdict of inferior or superior quality. For reporting on surgical quality, several indicators should be used to give a balanced view of the different aspects of quality and patient safety.

FOOTNOTES

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Competing interests

The authors have no competing interests.

Authors' contributions

AKL and OT conceived the study. DTK, TMH, OT, and SH participated in data preparation. OT, SH and AKL contributed to the analysis. OT helped draft the manuscript. JH was responsible for the statistical analysis and final manuscript. All authors revised and approved the final manuscript.

Ethics approval

The study was approved by the Norwegian Directorate of Health and the Norwegian Data Protection Authority.

Data sharing

The data set contains indirectly identifiable personal data, and cannot be shared without express permission from the Norwegian Patient Registry. For further information, contact the corresponding author.

Figure 1. Risk adjusted PWD rates versus yearly laparotomy volume, by hospital type. Trend curve is obtained by smoothing the scatterplot

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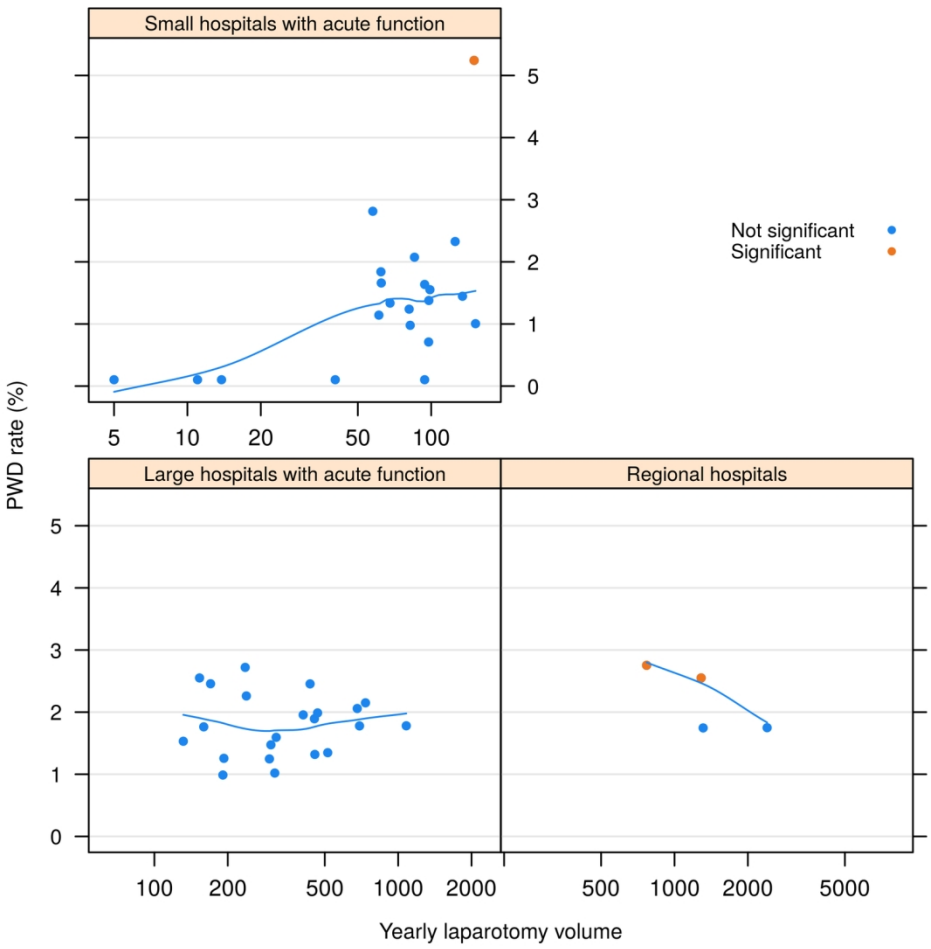

Figure 1. Risk adjusted PWD rates versus yearly laparotomy volume, by hospital type. Trend curve is obtained by smoothing the scatterplot

149x149mm (300 x 300 DPI)

Online supplement

Table 1. ICD-10 diagnosis codes contained in MDC 14 (Pregnancy, childbirth, and puerperium)

Code	Title
A34	Obstetrical tetanus
F53.0	Mild mental and behavioural disorders associated with the puerperium, not elsewhere classified
F53.1	Severe mental and behavioural disorders associated with the puerperium, not elsewhere classified
F53.8	Other mental and behavioural disorders associated with the puerperium, not elsewhere classified
F53.9	Puerperal mental disorder, unspecified
Oxx.x	Pregnancy, childbirth and puerperium
Z32.0	Pregnancy, not (yet) confirmed
Z32.1	Pregnancy confirmed
Z33	Pregnant state, incidental
Z34.0	Supervision of normal first pregnancy
Z34.8	Supervision of other normal pregnancy
Z34.9	Supervision of normal pregnancy, unspecified
Z35.0	Supervision of pregnancy with history of infertility
Z35.1	Supervision of pregnancy with history of abortive outcome
Z35.2	Supervision of pregnancy with other poor reproductive or obstetric history
Z35.3	Supervision of pregnancy with history of insufficient antenatal care
Z35.4	Supervision of pregnancy with grand multiparity
Z35.5	Supervision of elderly primigravida
Z35.6	Supervision of very young primigravida
Z35.8	Supervision of other high-risk pregnancies
Z35.9	Supervision of high-risk pregnancy, unspecified
Z36.0	Antenatal screening for chromosomal anomalies
Z36.1	Antenatal screening for raised alphafetoprotein level
Z36.2	Other antenatal screening based on amniocentesis
Z36.3	Antenatal screening for malformations using ultrasound and other physical methods
Z36.4	Antenatal screening for fetal growth retardation using ultrasound and other physical methods
Z36.5	Antenatal screening for isoimmunization
Z36.8	Other antenatal screening
Z36.9	Antenatal screening, unspecified
Z37.0	Single live birth
Z37.1	Single stillbirth
Z37.2	Twins, both liveborn
Z37.3	Twins, one liveborn and one stillborn
Z37.4	Twins, both stillborn
Z37.5	Other multiple births, all liveborn
Z37.6	Other multiple births, some liveborn
Z37.7	Other multiple births, all stillborn
Z37.9	Outcome of delivery, unspecified
Z39.0	Care and examination immediately after delivery
Z39.1	Care and examination of lactating mother
Z39.2	Routine postpartum follow-up
Z64.0	Problems related to unwanted pregnancy

Table 2. ICD-10 diagnosis codes for immunocompromised state

Code	Title
B20.0	HIV disease resulting in mycobacterial infection
B20.1	HIV disease resulting in other bacterial infections
B20.2	HIV disease resulting in cytomegaloviral disease
B20.3	HIV disease resulting in other viral infections
B20.4	HIV disease resulting in candidiasis
B20.5	HIV disease resulting in other mycoses
B20.6	HIV disease resulting in Pneumocystis carinii pneumonia
B20.7	HIV disease resulting in multiple infections
B20.8	HIV disease resulting in other infectious and parasitic diseases
B20.9	HIV disease resulting in unspecified infectious or parasitic disease
B21.0	HIV disease resulting in Kaposi's sarcoma
B21.1	HIV disease resulting in Burkitt's lymphoma
B21.2	HIV disease resulting in other types of non-Hodgkin's lymphoma
B21.3	HIV disease resulting in other malignant neoplasms of lymphoid, haematopoietic and related tissue
B21.7	HIV disease resulting in multiple malignant neoplasms
B21.8	HIV disease resulting in other malignant neoplasms
B21.9	HIV disease resulting in unspecified malignant neoplasm
B22.0	HIV disease resulting in encephalopathy
B22.1	HIV disease resulting in lymphoid interstitial pneumonitis
B22.2	HIV disease resulting in wasting syndrome
B22.7	HIV disease resulting in multiple diseases classified elsewhere
B23.1	HIV disease resulting in (persistent) generalized lymphadenopathy
B23.2	HIV disease resulting in haematological and immunological abnormalities, not elsewhere classified
B23.8	HIV disease resulting in other specified conditions
B24	Unspecified human immunodeficiency virus [HIV] disease
B59	Pneumocystosis
D47.1	Chronic myeloproliferative disease
D70	Agranulocytosis
D71	Functional disorders of polymorphonuclear neutrophils
D72.0	Genetic anomalies of leukocytes
D80.0	Hereditary hypogammaglobulinaemia
D80.1	Nonfamilial hypogammaglobulinaemia
D80.2	Selective deficiency of immunoglobulin A [IgA]
D80.3	Selective deficiency of immunoglobulin G [IgG] subclasses
D80.4	Selective deficiency of immunoglobulin M [IgM]
D80.5	Immunodeficiency with increased immunoglobulin M [IgM]
D80.6	Antibody deficiency with near-normal immunoglobulins or with hyperimmunoglobulinaemia
D80.7	Transient hypogammaglobulinaemia of infancy
D80.8	Other immunodeficiencies with predominantly antibody defects
D80.9	Immunodeficiency with predominantly antibody defects, unspecified
D81.0	Severe combined immunodeficiency [SCID] with reticular dysgenesis
D81.1	Severe combined immunodeficiency [SCID] with low T- and B-cell numbers
D81.2	Severe combined immunodeficiency [SCID] with low or normal B-cell numbers
D81.3	Adenosine deaminase [ADA] deficiency
D81.4	Nezelof's syndrome
D81.5	Purine nucleoside phosphorylase [PNP] deficiency
D81.6	Major histocompatibility complex class I deficiency
D81.7	Major histocompatibility complex class II deficiency
D81.8	Other combined immunodeficiencies
D81.9	Combined immunodeficiency, unspecified
D82.0	Wiskott-Aldrich syndrome

D82.1	Di George's syndrome
D82.2	Immunodeficiency with short-limbed stature
D82.3	Immunodeficiency following hereditary defective response to Epstein-Barr virus
D82.4	Hyperimmunoglobulin E [IgE] syndrome
D82.8	Immunodeficiency associated with other specified major defects
D82.9	Immunodeficiency associated with major defect, unspecified
D83.0	Common variable immunodeficiency with predominant abnormalities of B-cell numbers and function
D83.1	Common variable immunodeficiency with predominant immunoregulatory T-cell disorders
D83.2	Common variable immunodeficiency with autoantibodies to B- or T-cells
D83.8	Other common variable immunodeficiencies
D83.9	Common variable immunodeficiency, unspecified
D84.0	Lymphocyte function antigen-1 [LFA-1] defect
D84.1	Defects in the complement system
D84.8	Other specified immunodeficiencies
D84.9	Immunodeficiency, unspecified
D89.8	Other specified disorders involving the immune mechanism, not elsewhere classified
D89.9	Disorder involving the immune mechanism, unspecified
E40	Kwashiorkor
E41	Nutritional marasmus
E42	Marasmic kwashiorkor
E43	Unspecified severe protein-energy malnutrition
I12.0	Hypertensive renal disease with renal failure
I13.1	Hypertensive heart and renal disease with renal failure
I13.2	Hypertensive heart and renal disease with both (congestive) heart failure and renal failure
K91.2	Postsurgical malabsorption, not elsewhere classified
N18.0	End-stage renal disease
N18.5	Chronic kidney disease, stage 5
N18.8	Other chronic renal failure
T86.0	Bone-marrow transplant rejection
T86.1	Kidney transplant failure and rejection
T86.2	Heart transplant failure and rejection
T86.3	Heart-lung transplant failure and rejection
T86.4	Liver transplant failure and rejection
T86.8	Failure and rejection of other transplanted organs and tissues
T86.9	Failure and rejection of unspecified transplanted organ and tissue
Y83.0	Surgical Operation with transplant of whole organ or tissue
Z49.0	Preparatory care for dialysis
Z49.1	Extracorporeal dialysis
Z49.2	Other dialysis
Z94.0	Kidney transplant status
Z94.1	Heart transplant status
Z94.2	Lung transplant status
Z94.3	Heart and lungs transplant status
Z94.4	Liver transplant status
Z94.8	Other transplanted organ and tissue status
Z94.9	Transplanted organ and tissue status, unspecified

Procedure codes for laparotomy and operation types. Laparotomy codes are the total of codes in tables 3-16. Note that a last code digit of 0,3 or 6 signifies an open or other non-endoscopic operation or procedure.

Table 3. NCSP-N codes for reclosure procedures

Code	Title
JWA00	Repair of wound dehiscence in gastroenterological surgery
KWA00	Repair of wound dehiscence in urological surgery
LWA00	Repair of wound dehiscence in gynaecological surgery
PWA00	Repair of wound dehiscence in surgery of peripheral vessels and lymphatic system

Table 4. NCSP-N codes for repair of thoracoabdominal aorta

Code	Title
FCD00	Suture of thoracoabdominal aorta
FCD10	Reinforcement of thoracoabdominal aorta using suture
FCD30	Repair of thoracoabdominal aorta using patch
FCD40	Partial resection and suture of thoracoabdominal aorta
FCD50	Resection and reconstruction of thoracoabdominal aorta using tube graft
FCD60	Resection of thoracoabdominal aorta and reimplantation of branches
FCD70	Bypass of thoracoabdominal aorta using tube graft
FCD80	Removal of foreign body from thoracoabdominal aorta
FCD96	Other repair of thoracoabdominal aorta

Table 5. NCSP-N code for procedures on the abdominal wall

Code	Title
JAA00	Incision of abdominal wall

Table 6. NCSP-N codes for hernia repair

Code	Title
JBB00	Repair of paraoesophageal hernia
JBB10	Repair of congenital diaphragmatic hernia
JBB96	Repair of other diaphragmatic hernia
JBC00	Gastro-oesophageal antireflux operation

Table 7. NCSP-N codes for procedures on the digestive tract: oesophagus, stomach and intestines

Code	Title
JCA00	Oesophagotomy
JCA20	Ligature of oesophageal varices

JCA60	Transcervical excision of diverticulum of oesophagus
JCA96	Other local operation on oesophagus
JCB00	Oesophagostomy
JCC00	Transhiatal partial oesophagectomy without interposition
JCC10	Transthoracic partial oesophagectomy without interposition
JCC20	Transhiatal partial oesophagectomy with interposition of intestine
JCC30	Transthoracic partial oesophagectomy with interposition of intestine
JCC96	Other partial oesophagectomy
JCD00	Subcutaneous anastomosis of oesophagus without interposition
JCD03	Subcutaneous anastomosis of oesophagus with interposition of intestine
JCD10	Intrathoracic anastomosis of oesophagus without interposition
JCD13	Intrathoracic oesophageal anastomosis with interposition of intestine
JCD20	Transsection of oesophagus
JCD96	Other anastomosis of oesophagus without resection
JCE00	Suture of oesophagus
JCE10	Plastic repair of stenosis of cardia
JCE20	Cardiomyotomy
JCE30	Repair of oesophageal atresia or congenital tracheo-oesophageal fistula
JCE33	Closure of acquired tracheo-oesophageal or broncho-oesophageal fistula
JCE40	Reconstruction of oesophagus using flap
JCE50	Reconstruction of oesophagus using free microvascular graft of intestine
JCE96	Other reconstruction of oesophagus
JCF00	Insertion of oesophageal stent
JCW96	Other operation on oesophagus
JDA00	Gastrotomy
JDA60	Closure of perforated ulcer of stomach
JDA63	Local excision of lesion of stomach
JDC00	Partial gastrectomy and gastroduodenostomy
JDC10	Partial gastrectomy and gastrojejunostomy
JDC20	Partial gastrectomy and Roux-en-Y reconstruction
JDC30	Partial gastrectomy with interposition of jejunum
JDC40	Partial gastrectomy and oesophagogastrostomy
JDC96	Partial gastrectomy with other reconstruction
JDD00	Total gastrectomy and Roux-en-Y oesophagojejunostomy
JDD96	Total gastrectomy with other reconstruction
JDE00	Gastrojejunostomy
JDE10	Conversion of gastrojejunostomy to Roux-en-Y anastomosis
JDE20	Conversion of gastrojejunostomy to gastroduodenostomy with interposition of jejunum
JDE96	Other anastomosis of stomach without concurrent gastrectomy
JDF00	Gastroplasty
JDF10	Gastric bypass
JDF20	Gastric banding
JDF96	Other bariatric operation on stomach
JDG00	Truncal vagotomy
JDG10	Proximal gastric vagotomy
JDG96	Other vagotomy

JDH00	Duodenotomy
JDH40	Duodenostomy on duodenal bulb
JDH50	Local excision of lesion of duodenal bulb
JDH60	Pyloromyotomy
JDH63	Pyloroplasty
JDH70	Closure of perforated ulcer of duodenum
JDW96	Other operation on stomach or duodenum
JEA00	Appendectomy
JEA10	Appendectomy with drainage
JEW96	Other operation on appendix
JFA00	Enterotomy
JFA10	Colotomy
JFA16	Biopsy of wall of colon without colotomy
JFA60	Stricturoplasty in small intestine
JFA63	Stricturoplasty in colon
JFA70	Suture of small intestine
JFA73	Excision of lesion of small intestine
JFA76	Closure of fistula of small intestine
JFA80	Suture of colon
JFA83	Excision of lesion of colon
JFA86	Closure of fistula of colon
JFA96	Other local operation on intestine
JFB00	Partial resection of small intestine
JFB10	Reversal of segment of small intestine
JFB13	Plastic repair of small intestine with lengthening
JFB20	Ileocaecal resection
JFB30	Right hemicolectomy
JFB33	Other resection comprising small intestine and colon
JFB40	Resection of transverse colon
JFB43	Left hemicolectomy
JFB46	Resection of sigmoid colon
JFB50	Other resection of colon
JFB53	Resection of sigmoid colon with partial proctectomy
JFB60	Resection of sigmoid colon with end colostomy
JFB63	Other resection of colon with proximal colostomy and closure of distal stump
JFB96	Other partial excision of intestine
JFC00	Entero-enterostomy
JFC10	Ileotransversostomy
JFC20	Other enterocolostomy
JFC30	Colo-colostomy
JFC40	Ileorectostomy
JFC50	Colorectostomy
JFD00	Jejunoileal bypass
JFD03	Duodenoileal bypass with biliopancreatic diversion
JFD10	Revision of jejunoileal bypass
JFD13	Revision of duodenoileal bypass

JFD20	Restoration of continuity after jejunoileal bypass
JFD23	Restoration of continuity after duodenoileal bypass
JFD96	Other intestinal bypass operation
JFE00	Transplantation of small intestine
JFE96	Other operation relating to transplantation of small intestine
JFF00	Catheter enterostomy
JFF10	Loop enterostomy
JFF13	Terminal enterostomy
JFF20	Caecostomy
JFF23	Transversostomy
JFF26	Sigmoidostomy
JFF30	Other colostomy
JFF40	Appendicostomy
JFF50	Exteriorisation of loop of colon without opening
JFF60	Opening of exteriorised loop of colon
JFF96	Other exteriorisation of intestine or creation of intestinal stoma
JFG00	Closure of loop enterostomy without resection
JFG10	Closure of loop colostomy without resection
JFG20	Closure of enterostomy with resection of exteriorised loop
JFG23	Closure of terminal enterostomy with anastomosis to small intestine
JFG26	Closure of terminal enterostomy with anastomosis to colon
JFG30	Closure of colostomy with resection of exteriorised loop
JFG33	Closure of terminal colostomy with anastomosis to colon
JFG36	Closure of terminal colostomy with anastomosis to rectum
JFG40	Revision of enterostomy or colostomy without laparotomy
JFG50	Laparotomy with revision of enterostomy or colostomy
JFG53	Revision of ileal pelvic pouch
JFG56	Revision of colonic pelvic pouch
JFG60	Conversion of conventional ileostomy to continent ileostomy
JFG70	Conversion of continent ileostomy to conventional ileostomy
JFG73	Excision of ileal pelvic pouch
JFG76	Excision of colonic pelvic pouch with colorectal or coloanal anastomosis
JFG80	Excision of ileal pouch with construction of new continent ileostomy
JFG83	Excision of colonic pelvic pouch and construction of new pouch
JFG86	Excision of ileal pelvic pouch and construction of new pouch
JFG96	Other operation on intestinal stoma or pouch
JFH00	Total colectomy and ileorectal anastomosis
JFH10	Total colectomy and ileostomy
JFH20	Proctocolectomy and ileostomy
JFH30	Total colectomy, mucosal proctectomy and ileoanal anastomosis without ileostomy
JFH33	Total colectomy, mucosal proctectomy, ileoanal anastomosis and ileostomy
JFH40	Proctocolectomy and continent ileostomy
JFH96	Other total colectomy
JFJ00	Coecopexy
JFJ96	Other enteropexy or colopexy
JFK00	Division of adhesive band in intestinal obstruction

JFK10	Freeing of adhesions in intestinal obstruction
JFK20	Freeing of adhesions and plication of small intestine
JFK96	Other operation on adhesions in intestinal obstruction
JFL00	Open reduction of intussusception of intestine
JFL10	Laparotomy and manipulation of obstructed intestine
JFL20	Laparotomy and manipulation of impacted material
JFL96	Other operation for intestinal obstruction without resection or freeing of adhesions
JFM00	Intraoperative irrigation of colon
JFW96	Other operation on intestine
JGA00	Proctotomy
JGA60	Suture of rectum
JGA70	Proctotomy and excision of lesion of rectum
JGA73	Transanal excision of lesion of rectum
JGA76	Stapled transanal rectal resection
JGA96	Other proctotomy or local operation on rectum
JGB00	Partial proctectomy and colorectal or coloanal anastomosis
JGB03	Partial proctectomy with partial excision of mesorectum
JGB06	Partial proctectomy with total excision of mesorectum
JGB10	Partial proctectomy and end colostomy
JGB20	Partial rectosigmoidectomy and abdominoperineal pull-through anastomosis
JGB30	Abdominoperineal excision of rectum
JGB33	Abdominoperineal excision of rectum with intersphincteric dissection
JGB36	Wide excision of rectum
JGB40	Excision of rectum and end ileostomy
JGB50	Mucosal proctectomy and ileoanal anastomosis
JGB60	Excision of rectum and ileoanal anastomosis
JGB96	Other proctectomy or excision of rectum
JGC00	Rectopexy
JGC10	Perineal rectopexy
JGC20	Transanal suture
JGC30	Excision and suture of rectal mucosa with imbrication of muscular layer
JGC40	Anorectal repair of anal atresia
JGC96	Other reconstructive operation on rectum
JGD00	Excision of perineal local recurrence of tumour
JGW96	Other operation on rectum

Table 8. NCSP-N codes for procedures on the liver

Code	Title
JJA00	Exploration of liver
JJA10	Hepatotomy
JJA20	Open biopsy of liver
JJA23	Open needle biopsy of liver
JJA30	Fenestration of cyst of liver
JJA40	Excision of lesion of liver

JJA43	Destruction of lesion of liver
JJA50	Suture of liver
JJA96	Other local operation on liver
JJB00	Wedge resection of liver
JJB10	Atypical resection of liver
JJB20	Excision of single segment of liver
JJB30	Excision of two segments of liver
JJB40	Excision of segments II, III and IV of liver
JJB50	Excision of segments V, VI, VII and VIII of liver
JJB53	Excision of segments IV,V, VI, VII and VIII of liver
JJB60	Other excision of three or more segments of liver
JJB96	Other resection of liver
JJC00	Allogenic transplantation of liver
JJC10	Allogenic partial transplantation of liver
JJC20	Allogenic partial transplantation of liver from living donor
JJC30	Xenogenic transplantation of liver
JJC40	Xenogenic partial transplantation of liver
JJC50	Resection of transplanted liver
JJC60	Total excision of transplanted liver
JJC96	Other transplantation of liver or related operation
JJW96	Other operation on liver

Table 9. NCSP-N codes for procedures on biliary tract

Code	Title
JKA00	Cholecystotomy
JKA10	Cholecystostomy
JKA13	Percutaneous cholecystostomy
JKA20	Cholecystectomy
JKA96	Other operation on gallbladder
JKB00	Incision of bile duct
JKB20	Intraoperative cholangioscopy
JKB40	Suture of bile duct
JKB96	Other incision or related operation on bile duct
JKC00	Incision of bile duct and local excision of lesion
JKC10	Partial excision and anastomosis of bile duct
JKC20	Partial excision of bile duct and anastomosis to duodenum
JKC30	Partial excision of bile duct and anastomosis to jejunum
JKC40	Partial excision of right or left hepatic duct and anastomosis to jejunum
JKC50	Excision of papilla of Vater and anastomosis of bile duct to duodenum or jejunum
JKC96	Other excision of bile duct
JKD00	Anastomosis of gallbladder to jejunum
JKD10	Anastomosis of bile duct to duodenum
JKD20	Anastomosis of bile duct to jejunum

JKD30	Extrahepatic anastomosis of right or left hepatic duct to jejunum
JKD40	Anastomosis of intrahepatic bile duct to jejunum
JKD50	Hepatoportoenterostomy
JKD96	Other biliodigestive anastomosis without excision
JKE00	Transduodenal papillotomy
JKE06	Transduodenal sphincteroplasty
JKE96	Other transduodenal open operation on bile duct or ampulla of Vater
JKF00	Excision of cystic duct
JKF10	Percutaneous extraction of biliary calculus
JKF96	Other secondary operation on biliary tract
JKW96	Other operation on biliary tract

Table 10. NCSP-N codes for procedures on the pancreas

Code	Title
JLA00	Exploration of pancreas
JLA10	Biopsy of pancreas
JLA20	Needle biopsy of pancreas
JLB00	Incision of pancreas
JLB10	Pancreaticolithotomy
JLB96	Other incision, drainage or dilatation of pancreas
JLC00	Excision of lesion of pancreas
JLC10	Distal pancreatectomy
JLC20	Total pancreatectomy
JLC30	Pancreatoduodenectomy
JLC40	Total pancreatoduodenectomy
JLC50	Atypical pancreatectomy
JLC96	Other pancreatectomy
JLD00	Pancreaticojejunostomy
JLD10	Anastomosis of pancreatic pseudocyst to stomach
JLD20	Anastomosis of pancreatic pseudocyst to jejunum
JLE00	Allogenic total transplantation of pancreas with pancraticocystostomy
JLE03	Allogenic total transplantation of pancreas with pancreaticoenterostomy
JLE10	Allogenic segmental transplantation of pancreas
JLE16	Allogenic segmental transplantation of pancreas from living donor
JLE20	Allogenic islet cell transplantation
JLE30	Xenogenic islet cell transplantation
JLE40	Total excision of transplanted pancreas
JLE50	Occlusion of duct of transplanted pancreas
JLE56	Conversion of pancreaticocystostomy to pancreaticoenterostomy
JLE96	Other transplantation of pancreas or related operation
JLW96	Other operation on pancreas

Table 11. NCSP-N codes for procedures on the spleen

Code	Title
JMA00	Partial splenectomy
JMA10	Transabdominal total splenectomy
JMA20	Transthoracic total splenectomy
JMB00	Biopsy of spleen
JMB10	Repair of spleen
JMW96	Other operation on spleen

Table 12. NCSP-N codes for other digestive system procedures

Code	Title
JAH00	Laparotomy
JAH20	Staging laparotomy
JAH30	Laparostomy
JAH33	Revision of laparostomy
JAH40	Thoracolaparotomy
JAJ00	Rectal incision and drainage of pelvic abscess
JAK00	Laparotomy and drainage of peritoneal cavity
JAK03	Laparotomy and peritoneal irrigation
JAK10	Laparotomy and insertion of peritoneal dialysis catheter
JAL00	Biopsy of peritoneum
JAL10	Laparotomy and removal of foreign body
JAL20	Excision or destruction of lesion of peritoneum
JAL23	Excision of local lesion of pelvic wall
JAL30	Omentectomy
JAL50	Intraabdominal revision of shunt of ventricle of brain
JAL96	Other local operation on peritoneum or peritoneal cavity
JAM00	Transposition of omentum
JAM10	Operation for malrotation of intestine
JAN00	Creation of peritoneovenous shunt
JAN10	Revision of peritoneovenous shunt
JAN20	Removal of peritoneovenous shunt
JAP00	Freeing of adhesions in the peritoneal cavity
JAQ00	Extensive excision of peritoneum
JAQ10	Intraoperative hypertermic chemotherapeutic perfusion of abdominal cavity
JAW96	Other operation on abdominal wall, peritoneum, mesentery or omentum
JBA00	Transabdominal repair of diaphragm for rupture
JBA10	Transabdominal biopsy or excision of lesion of diaphragm
JBA20	Transabdominal partial excision of diaphragm
JBW96	Other transabdominal operation on diaphragm or operation for gastro-oesophageal reflux
JKT00	Extracorporeal shock wave lithotripsy of gallbladder
JKT10	Extracorporeal shock wave lithotripsy of biliary duct

Table 13. NCSP-N codes for procedures on kidney and pelvis of kidney

Code	Title
KAA00	Exploration of kidney
KAA20	Exploratory nephrotomy
KAA30	Exploratory pyelotomy
KAA96	Other exploration of kidney or pelvis of kidney
KAB00	Biopsy of kidney or pelvis of kidney
KAC00	Nephrectomy
KAC20	Nephroureterectomy
KAD00	Partial nephrectomy
KAD10	Heminephrectomy
KAD40	Partial excision of pelvis of kidney
KAD50	Destruction of tumour of pelvis of kidney
KAD56	Destruction of lesion of renal parenchyma
KAD60	Percutaneous destruction of lesion of renal parenchyma
KAD96	Other partial excision of kidney or pelvis of kidney
KAE00	Nephrolithotomy
KAE10	Pyelolithotomy
KAE96	Other removal of calculus from kidney or pelvis of kidney
KAF00	Removal of foreign body from kidney
KAF10	Removal of foreign body from pelvis of kidney
KAH00	Suture of kidney
KAH10	Suture of pelvis of kidney
KAH30	Pyeloureteroplasty without division of ureteropelvic junction
KAH40	Pyeloureteroplasty with division of ureteropelvic junction
KAH50	Ureterocalyceal anastomosis
KAH70	Freeing of adhesions of ureteropelvic junction
KAH80	Nephropexy
KAH96	Other reconstruction of kidney or pelvis of kidney
KAS00	Autotransplantation of kidney
KAS10	Allogenic transplantation of kidney from cadaver donor
KAS20	Allogenic transplantation of kidney from living donor
KAS40	Excision of transplanted kidney
KAS50	Nephrocystostomy in transplanted kidney
KAS60	Operation for lymphocele of transplanted kidney
KAS96	Other transplantation of kidney or related procedure
KAW96	Other operation on kidney or pelvis of kidney

Table 14. NCSP-N codes for procedures on other urinary and male genital organs: ureter, bladder, urethra, prostate and seminal vesicles

Code	Title
KBA00	Exploration of ureter
KBA10	Exploratory ureterotomy
KBA96	Other exploration of ureter
KBB00	Biopsy of ureter
KBC00	Ureterectomy
KBD00	Partial excision of ureter
KBD20	Destruction of tumour of ureter
KBD30	Excision of stump of ureter
KBD96	Other partial excision of ureter or destruction of tumour of ureter
KBE00	Ureterolithotomy
KBE96	Other operation for calculus of ureter
KBF00	Removal of foreign body from ureter
KBH00	Suture of ureter
KBH06	Ureteroureterostomy
KBH10	Connection of ureter to contralateral ureter
KBH20	Replantation of ureter
KBH30	Ileal replacement of ureter
KBH40	Plastic repair of ureter
KBH50	Ureterolysis
KBH96	Other repair or connection of ureter
KBJ00	Cutaneous ureterostomy
KBJ10	Cutaneous ureteroenterostomy
KBJ20	Cutaneous ureteroenterostomy with reservoir
KBJ40	Ureteroenterostomy
KBJ60	Anastomosis of ureter to urethra with interposition of ileum
KBJ70	Removal of calculus from ileal conduit or reservoir
KBJ80	Operation for malfunction of urinary diversion
KBJ96	Other urinary diversion from ureter or related operation
KBT00	Extracorporeal shock wave lithotripsy of ureter
KBV00	Insertion of stent into ureter
KBV10	Removal of stent from ureter
KBV40	Incision or excision of ureterocele
KBW96	Other operation on ureter
KCA00	Exploratory cystotomy
KCB00	Biopsy of bladder
KCC00	Cystectomy
KCC10	Cystoprostatectomy
KCC20	Cystoprostatourethrectomy
KCC30	Cystectomy with excision of female internal genital organs
KCC96	Other cystectomy
KCD10	Partial cystectomy

KCD20	Excision of diverticulum of bladder
KCD30	Destruction of tumour of bladder
KCD40	Excision of urachus
KCD96	Other partial excision or destruction of tumour of bladder
KCE00	Cystolithotomy
KCF00	Cystotomy and removal of foreign body from bladder
KCH00	Suture of bladder
KCH10	Enterocystoplasty
KCH20	Reduction cystoplasty
KCH30	Closure of vesicointestinal fistula
KCH40	Incision or resection of bladder neck
KCH96	Other reconstructive operation on bladder
KCJ00	Cystostomy
KCJ10	Cutaneous cystoenterostomy
KCJ20	Continent cutaneous cystoenterostomy
KCJ96	Other cystostomy
KCT00	Extracorporeal shock wave lithotripsy of bladder
KCV10	Denervation of bladder
KCV20	Freeing of bladder
KCW96	Other operations on bladder
KDC00	Urethrectomy
KDD00	Partial excision of urethra
KDD10	Excision of diverticulum of urethra
KDD30	Destruction of tumour of urethra
KDD40	Resection of external sphincter of urethra
KDD50	Excision of urethral valve
KDD80	Partial excision of urethra and repair using graft or flap
KDD96	Other partial excision of urethra
KDG00	Retropubic suspension of urethra
KDG10	Abdominovaginal suspension of bladder neck
KDG20	Abdominal colposuspension
KDG30	Suprapubic sling urethrocystopexy
KDG40	Suprapubic urethrocystopexy
KDG43	Transobturatorial sling urethrocystopexy
KDG50	Transabdominal plastic repair of pelvic floor for urinary incontinence
KDG60	Implantation of adjustable expander around bladder neck
KDG96	Other operation on urethra or bladder neck for incontinence
KDH00	Suture of urethra
KDH10	Meatoplasty of urethra
KDH30	Closure of urethrocutaneous fistula
KDH50	Closure of urethrointestinal fistula
KDH70	Plastic repair of stricture of urethra
KDH96	Other reconstructive operation on urethra
KDJ00	Urethrostomy

KDK00	Implantation of artificial urinary sphincter around bladder neck
KDK10	Implantation of artificial urinary sphincter around bulbar urethra
KDK30	Revision of artificial urethral sphincter
KDK40	Removal of artificial urethral sphincter
KDV00	Insertion of stent into urethra
KDV10	Internal urethrotomy
KDV20	Submucous urethral injection
KDW96	Other operation on urethra
KEA00	Exploration of prostate
KEA10	Prostatotomy
KEA20	Incision of seminal vesicle
KEC00	Retropubic radical prostatectomy
KEC10	Perineal radical prostatectomy
KEC20	Transsacral radical prostatectomy
KED00	Transvesical prostatectomy
KED80	Percutaneous cryotherapy of prostate
KED96	Other partial excision of prostate
KEE00	Prostatolithotomy
KEE10	Removal of foreign body from prostate
KEW96	Other operation on prostate or seminal vesicle

Table 15- NCSP-N codes for procedures on female genital organs: ovary, fallopian tube, uterus and uterine ligaments

Code	Title
LAA00	Puncture of ovarian cyst
LAB00	Ovariotomy
LAB10	Biopsy of ovary
LAB96	Other incision or biopsy of ovary
LAC00	Excision of ovarian cyst
LAC10	Fenestration of ovarian cyst
LAC20	Destruction of lesion of ovary
LAC30	Excision of paraovarian cyst
LAC96	Other excision or destruction of lesion of ovary
LAD00	Partial excision of ovary
LAE10	Unilateral oophorectomy
LAE20	Bilateral oophorectomy
LAF00	Unilateral salpingo-oophorectomy
LAF10	Bilateral salpingo-oophorectomy
LAF20	Unilateral transvaginal salpingo-oophorectomy
LAF30	Bilateral transvaginal salpingo-oophorectomy
LAG00	Freeing of adhesions of ovary
LAG10	Oophoropexy

LAG20	Detorsion of ovary
LAG96	Other reconstructive operation on ovary
LAW96	Other operation on ovary
LBB00	Biopsy of Fallopian tube
LBB96	Other biopsy of Fallopian tube
LBC10	Removal of products of conception from Fallopian tube
LBC20	Salpingotomy and removal of products of conception
LBC96	Other tube conserving operation for tubal pregnancy
LBD00	Partial excision of Fallopian tube
LBE00	Salpingectomy
LBF00	Perfusion of Fallopian tube
LBF03	Perfusion of Fallopian tube after reconstruction
LBF20	Transcervical catheter salpingoplasty
LBF30	Salpingolysis
LBF40	Fimbrioplasty
LBF50	Salpingostomy
LBF60	Partial excision and anastomosis of Fallopian tube
LBF70	Partial excision and reimplantation of Fallopian tube
LBF96	Other operation on Fallopian tube for infertility
LBW96	Other operation on Fallopian tube
LCA00	Biopsy of uterus or uterine ligaments
LCB00	Hysterotomy
LCB10	Myomectomy
LCB20	Transvaginal myomectomy
LCB96	Other excision of lesion of uterus
LCC00	Partial excision of uterus
LCC10	Supravaginal hysterectomy
LCC20	Vaginal supravaginal hysterectomy
LCC96	Other partial excision of uterus
LCD00	Hysterectomy
LCD10	Vaginal hysterectomy
LCD30	Radical hysterectomy
LCD40	Radical vaginal hysterectomy
LCD96	Other hysterectomy
LCE00	Anterior exenteration of female pelvis
LCE10	Posterior exenteration of female pelvis
LCE20	Total exenteration of female pelvis
LCE96	Other exenteration of female pelvis
LCF00	Excision of lesion of parametrium
LCF10	Excision of female varicocele
LCF96	Other excision of lesion of parametrium
LCG10	Suture of uterus
LCG20	Hysteropexy
LCG30	Resection or transcision of sacrouterine ligaments

LCG40	Reconstruction of uterus
LCG96	Other reconstructive operation on uterus
LCW96	Other operation on uterus and uterine ligaments

Table 16. NCSP-N codes for procedures on the peripheral vessels of the abdomen

Code	Title
PCB20	Ligature of coeliac trunk and branches
PCB30	Ligature of superior mesenteric artery
PCB40	Ligature of renal artery
PCB99	Ligature of other visceral artery
PCC10	Suture of suprarenal or juxtarenal abdominal aorta
PCC20	Suture of coeliac trunk and branches
PCC30	Suture of superior mesenteric artery
PCC40	Suture of renal artery
PCC99	Suture of other visceral artery
PCE30	Thrombectomy or embolectomy of superior mesenteric artery
PCE40	Thrombectomy or embolectomy of renal artery
PCE99	Thrombectomy or embolectomy of other visceral artery
PCF20	Thrombendarterectomy of coeliac trunk and branches
PCF30	Thrombendarterectomy of superior mesenteric artery
PCF40	Thrombendarterectomy of renal artery
PCF99	Thrombendarterectomy of other visceral artery
PCG10	Operation for aneurysm of supracoeliac or juxtarenal abdominal aorta
PCG20	Operation for aneurysm of coeliac trunk and branches
PCG30	Operation for aneurysm of superior mesenteric artery
PCG40	Operation for aneurysm of renal artery
PCG99	Operation for aneurysm of other visceral artery
PCH10	Bypass from supracoeliac or juxtarenal abdominal aorta
PCH20	Bypass from coeliac trunk and branches
PCH30	Bypass from superior mesenteric artery
PCH40	Bypass from renal artery
PCH99	Bypass from other visceral artery
PCJ30	Transposition of superior mesenteric artery
PCJ40	Transposition of renal artery
PCJ99	Transposition of other visceral artery
PCK20	Reimplantation of coeliac trunk and branches
PCK30	Reimplantation of superior mesenteric artery
PCK40	Reimplantation of renal artery
PCK50	Reimplantation of inferior mesenteric artery
PCK99	Reimplantation of other visceral artery
PCN20	Plastic repair of coeliac trunk and branches

PCN30	Plastic repair of superior mesenteric artery
PCN40	Plastic repair of renal artery
PCN99	Plastic repair of other visceral artery
PCU70	Exploration of previous reconstruction of suprarenal abdominal aorta or visceral arteries
PCU74	Thrombectomy or embolectomy in bypass from suprarenal abdominal aorta and visceral arteries
PCU81	Closure of persisting arteriovenous fistula of bypass from suprarenal abdominal aorta and visceral arteries
PCU82	Plastic repair in bypass from suprarenal abdominal aorta and visceral arteries
PCU99	Other repair after previous reconstruction of suprarenal abdominal aorta and visceral arteries
PCW99	Other operation on suprarenal abdominal aorta and visceral arteries
PDA10	Exploration of infrarenal abdominal aorta
PDA30	Exploration of iliac artery
PDC10	Suture of infrarenal abdominal aorta
PDC30	Suture of iliac artery
PDE10	Thrombectomy or embolectomy of infrarenal abdominal aorta
PDE30	Thrombectomy or embolectomy of iliac artery
PDF10	Thrombendarterectomy of infrarenal abdominal aorta
PDF30	Thrombendarterectomy of iliac artery
PDG10	Operation on infrarenal abdominal aorta for aneurysm
PDG20	Bypass from aorta to iliac artery for aneurysm
PDG21	Bypass from aorta to bilateral iliac arteries for aneurysm
PDG22	Bypass from aorta to iliac and contralateral femoral artery for aneurysm
PDG23	Bypass from aorta to femoral artery for aneurysm
PDG24	Bypass from aorta to bilateral femoral arteries for aneurysm
PDG30	Operation on iliac artery for aneurysm
PDG35	Bypass from iliac to femoral artery for aneurysm
PDG99	Other operation for aneurysm of infrarenal abdominal aorta and iliac arteries
PDH10	Bypass from infrarenal abdominal aorta
PDH20	Bypass from aorta to iliac artery
PDH21	Bypass from aorta to bilateral iliac arteries
PDH22	Bypass from aorta to iliac and contralateral femoral artery
PDH23	Bypass from aorta to femoral artery
PDH24	Bypass from aorta to bilateral femoral arteries
PDH30	Bypass from iliac artery
PDH35	Bypass from iliac to femoral artery
PDH99	Other bypass from abdominal aorta or iliac artery
PDN10	Plastic repair of infrarenal abdominal aorta
PDN30	Plastic repair of iliac artery
PDU70	Exploration of previous reconstruction of infrarenal abdominal aorta or iliac arteries and distal connections
PDU74	Thrombectomy or embolectomy in bypass from infrarenal abdominal aorta or iliac artery
PDU81	Closure of persisting arteriovenous fistula of bypass from infrarenal abdominal aorta or iliac artery
PDU82	Plastic repair of bypass from infrarenal abdominal aorta or iliac artery

PDU99	Other repair after previous reconstruction of infrarenal abdominal aorta and iliac arteries and distal
PDW99	Other operation on infrarenal abdominal aorta and iliac arteries and distal connections
PHB23	Ligature of iliac vein
PHB30	Ligature of inferior vena cava
PHB31	Ligature of renal vein
PHB32	Ligature of portal vein
PHB33	Ligature of superior mesenteric vein
PHB34	Ligature of inferior mesenteric vein
PHB36	Ligature of spermatic vein
PHC23	Suture of iliac vein
PHC30	Suture of inferior vena cava
PHC31	Suture of renal vein
PHC32	Suture of portal vein
PHC33	Suture of superior mesenteric vein
PHC34	Suture of inferior mesenteric vein
PHD30	Resection of inferior vena cava
PHD32	Resection of portal vein
PHD33	Resection of superior mesenteric vein
PHD34	Resection of inferior mesenteric vein
PHD36	Resection of spermatic vein
PHE23	Thrombectomy of iliac vein
PHE30	Thrombectomy of inferior vena cava
PHE31	Thrombectomy of renal vein
PHH25	Bypass from iliac vein
PHH30	Bypass from inferior vena cava
PHN30	Plastic repair of inferior vena cava
PHN32	Plastic repair of portal vein
PHN33	Plastic repair of superior mesenteric vein
PHN34	Plastic repair of inferior mesenteric vein
PHW35	Portosystemic shunt or bypass

The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	Title	RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	Title and abstract Abstract l 21 Title and abstract l 20-21 No linkages between databases
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported	Introduction, l 49-73		
Objectives	3	State specific objectives, including any prespecified hypotheses	Introduction, l 74-79		
Methods					
Study Design	4	Present key elements of study design early in the paper	Abstract, l 20-30.		
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Materials and methods		
Participants	6	*(a) Cohort study* - Give the eligibility criteria, and the	Materials and methods, l. 81-82	RECORD 6.1: The methods of study population selection (such as codes or	Materials and methods, l 96-109.

		sources and methods of selection of participants. Describe methods of follow-up *Case-control study* - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants *(b) Cohort study* - For matched studies, give matching criteria and number of exposed and unexposed *Case-control study* - For matched studies, give matching criteria and the number of controls per case	and l 96-109	algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	All codes are listed in the Supplementary File References to validation studies are given in Introduction, l 66-69, and in Discussion, l 196 Not considered relevant
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	Materials and methods, l 96-109, and Supplementary File. Model variables are specified in Statistical methods, l. 115-120	RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	Codes are listed in the Supplementary File
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Covered by the above		
Bias	9	Describe any efforts to address potential sources of bias	Hospital PWD rates are risk adjusted, see		

			statistical methods l 115-120		
Study size	10	Explain how the study size was arrived at	Determined by study period		
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	Model variables are specified in Statistical methods, l. 115-120		
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses	a) See Statistical methods c) No missing data were found in final data set d) Loss to follow up assumed to be very low and uniform across hospitals e) Materials and methods, l 131-134, Results, l 173-174		
Data access and cleaning methods		..		RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population. RECORD 12.2: Authors should provide information on the data cleaning	The authors had no accesss to the NPR's databases Materials and methods, l 89-91

				methods used in the study.	
Linkage		..		RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	NPR provided linkage to National Registry using the unique PIN
Results					
Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed) (b) Give reasons for non-participation at each stage. (c) Consider use of a flow diagram	Results, l 146-151	RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	
Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders (b) Indicate the number of participants with missing data for each variable of interest (c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)	a) Results, Table 1 b) See above c) Not relevant		
Outcome data	15	*Cohort study* - Report numbers of outcome events or summary measures over time *Case-control study* - Report numbers in each exposure category, or summary measures of exposure *Cross-sectional study* - Report	Results, Table 1		

		numbers of outcome events or summary measures			
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Results, l 156-157 and Figure 1, Table 2		
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	Results, l 168-174, Figure 1		
Discussion					
Key results	18	Summarise key results with reference to study objectives	Discussion, l 176-184		
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias		RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	Discussion, l 198-218
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Conclusions, l 220-231		

Generalisability	21	Discuss the generalisability (external validity) of the study results	Discussion, l 214-218		
Other Information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	No specific funding was received		
Accessibility of protocol, raw data, and programming code		..		RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	Contact the corresponding author

*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.

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POSTOPERATIVE WOUND DEHISCENCE AFTER LAPAROTOMY: A USEFUL HEALTH CARE QUALITY INDICATOR? A COHORT STUDY BASED ON NORWEGIAN HOSPITAL ADMINISTRATIVE DATA

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POSTOPERATIVE WOUND DEHISCENCE AFTER LAPAROTOMY: A USEFUL HEALTH CARE QUALITY INDICATOR? A COHORT STUDY BASED ON NORWEGIAN HOSPITAL ADMINISTRATIVE DATA

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ABSTRACT

Objectives

Postoperative wound dehiscence (PWD) is a serious complication to laparotomy, leading to higher mortality, readmissions and cost. The aims of the present study are to investigate whether risk adjusted PWD rates could reliably differentiate between Norwegian hospitals, and whether PWD rates were associated with hospital characteristics such as hospital type and laparotomy volume.

Design

Observational study using patient administrative data from all Norwegian hospitals, obtained from the Norwegian Patient Registry, for the period 2011-2015, and linked using the unique person identification number.

Participants

All patients undergoing laparotomy, at least 15 years old, with length of stay at least two days, and no diagnosis code for immunocompromised state or relating to pregnancy, childbirth and puerperium. The final data set comprised 66 925 patients with 78 086 laparotomy episodes from 47 hospitals.

Outcomes

The outcome was wound dehiscence, identified by the presence of a wound reclosure code, risk adjusted for patient characteristics and operation type.

Results

The final data set comprised 1 477 wound dehiscences. Crude PWD rates varied from 0% to 5.1% among hospitals, with an overall rate of 1.89%. Three hospitals with statistically significantly higher PWD than average were identified, after case mix adjustment and correction for multiple comparisons. Hospital volume was not associated with PWD rate, except that hospitals with very few laparotomies had lower PWD rates.

Conclusions

Among Norwegian hospitals, there is considerable variation in PWD rate that cannot be explained by operation type, age or comorbidity. This warrants further investigation into possible causes, such as surgical technique, perioperative procedures or handling of complications. The risk adjusted PWD rate after laparotomy is a candidate quality indicator for Norwegian hospitals.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- Includes all laparotomies performed in the nation over a five-year period, with patients followed across hospitals
- Extends previous studies to a new health system and a new coding system
- The statistical analysis uses methods for low event rates, avoiding asymptotic approximation
- Results may be subject to coding inaccuracy and incompleteness, as well as selection effects
- There were no data for surgical technique, nor for some clinical factors known to be relevant.

INTRODUCTION

The past decades have seen a major growth in initiatives for measuring, monitoring, and improving the quality of health care services. Quality indicators are regularly published in many health care systems. Performance of health care systems is also compared across nations, for instance in the OECD Health Care Quality and Outcomes (HCQO) initiative, which Norway is a part of.[1 2] Norway has a national quality indicator system for monitoring and comparing hospital performance, however, not all areas of hospital performance are covered by existing national quality indicators. While there are quality indicators for outcomes such as mortality and process measures such as waiting times, complications following hospital care is less explored, which is especially relevant following surgical procedures.

Postoperative wound dehiscence (PWD) rates after open abdominal surgery (laparotomies) was introduced as a patient safety indicator in the United States and later as a quality indicator by OECD.[3-6] Norway reported the second highest numbers for 2014-2015, with a PWD rate of 1.02%. The overall range was 0.055% to 1.05%.[5] Neighbouring Sweden, with comparable population health and health care, reported 0.30%. Moreover, a recent study comparing adverse events in Norway and Sweden found significantly higher adverse event rates of surgical complications in Norwegian hospitals, compared to Swedish hospitals.[7]

PWD is a serious complication that leads to higher mortality rates, higher implicit, explicit and social costs as well as increased readmission rates.[8 9] The PWD rate has been studied elsewhere as a quality indicator for hospitals, and found to have a high positive predictive value.[10 11] It is useful as a quality indicator, since several of the risk factors are modifiable and within control of the hospital and surgical team. There are few events per hospital, making it challenging to identify outlier hospitals for quality improvement because of the high statistical uncertainty.

Previous research has identified a number of risk factors for PWD. Examples of such factors are: (I) patient related variables and comorbidities: smoking[12], obesity[13], chronic pulmonary disease, renal insufficiency or diabetes[14] and use of immunosuppressive agents[15 16]; (II) procedure related factors: operation type[9 17], type of incision and closure[18-20] and length of operation time[21]; (III) postoperative parameters: clean wound classification[21], coughing[9] and wound infection[9 14]; (IV) operative scenario: e.g. qualifications of the surgeon[21-23] and of the perioperative team, and whether the surgery is emergent.[9 13]

The objectives of this study are to study the occurrence and variation of PWD after laparotomy at Norwegian hospitals, and the potential usefulness of a PWD indicator for the Norwegian health care system, computed from patient administrative data. More specifically we aimed to 1) investigate the possibility to identify hospitals with higher or lower laparotomy PWD rate than average, after appropriate risk adjustment, 2) study the variability of the PWD rate among hospitals, and its relation to hospital type and laparotomy volume.

MATERIAL AND METHODS

Patient administrative data from all Norwegian hospitals were provided by the Norwegian Patient Registry (NPR) for the period 2011-2015.[24] This comprised individual patient data from all department stays: type of admission (acute or elective), primary and secondary diagnosis codes according to the Norwegian version[25] of ICD-10, surgical and medical procedures, age, gender, date and time of ward admission and discharge. Surgical procedures and operations were coded according to the Norwegian version of the NOMESCO Classification of Surgical Procedures (NCSP-N).[26] Procedure time and date were not available. It was therefore not possible to exclude reclosures of wounds occurring before or on the same day as laparotomies within the same episode, as requested in the OECD indicator specification. The NPR data files were checked for missing values and

inconsistencies between variables, such as date and time of discharge before admission or invalid ICD-10 code.

Wound dehiscence was defined as the occurrence of a code for a reclosure operation, i.e. a reoperation for wound dehiscence. This excludes superficial dehiscences, as these are usually not resutured, and the code for reclosure operation is restricted to deep wound dehiscences. Laparotomies and wound reclosure operations were identified according to procedure codes. An operation coded with a laparotomy code, signifies an incision into the abdominal wall, through the fascia and with an opening of the abdominal cavity. Laparoscopic and endoscopic procedures were not included. Details of the codes used can be found in the online supplement.

All permanent residents in Norway have a Personal Identification Number (PIN), registered in the NPR. NPR prepared an encrypted PIN for all patients with a valid PIN, allowing tracking of patients over time and between hospitals. The data were linked with the National Registry to provide data of death (when applicable), using the PIN.

Ward admissions for each patient, at more than one hospital in case of transfers, were linked into episodes of care when less than eight hours elapsed from time of discharge to the next ward admission.[27] An episode was regarded as acute if the first admission in the episode was coded as non-elective, as a laparotomy episode if it included any procedure code for laparotomy (reclosures not included), and a reclosure episode if a reclosure code was found. The initial data set consisted of all laparotomy and reclosure episodes. Each reclosure episode was linked to the laparotomy episode immediately preceding or coinciding with it. Reclosure episodes with no preceding laparotomy episode within 30 days, as well as laparotomy or reclosure episodes following a reclosure episode within 30 days, were excluded. Note that the linking of laparotomies and reclosures was not part of the original OECD specification, but is required in order to attribute PWD to hospitals and to enable risk adjustment. Following the OECD specification, laparotomy episodes (and consequently any

linked reclosure episodes) were excluded if a diagnosis code for immunocompromised state or relating to pregnancy, childbirth and puerperium was present, if the length of stay was less than two days, or if the patient's age was less than 15 years. Hospitals with less than 10 laparotomies over the five-year period were excluded. The hospitals belonged to one of three types: regional, large with acute function and small with acute function. For details of the diagnosis and operation codes used, see the online supplement. For risk adjustment, Charlson comorbidities were determined from previous admissions three years prior to, but not including the current episode of care.[27-29] Diagnoses were grouped according to the Clinical Condition Summary system (CCS), adapted to the Norwegian version of ICD-10.[30]

Statistical methods

Risk adjusted probabilities for a laparotomy episode resulting in a reclosure operation were estimated by bias corrected logistic regression.[31] The final model was fit by stepwise regression with the BIC criterion, allowing for potential two-way interactions.

To identify outlier hospitals, i.e. those with high or low risk adjusted PWD probabilities, estimated hospital effects were compared to a reference value, defined as the 25% trimmed mean of the hospital effects on the logistic scale.[32] As some hospitals reported zero reclosures, ordinary maximum likelihood estimates of the model parameters do not exist, due to separation[33], and the estimated variances of the fitted parameters, based on their asymptotic distribution, become unreliable. The comparison used an exact test based on the Poisson binomial distribution for the number of PWDs per hospital, using the estimated probabilities for each case, together with parametric bootstrapping to account for the estimation uncertainty in the model parameters. Tests for significance were corrected for multiple comparisons using the Guo-Romano method[34], and outlier status assigned according to the false discovery rate (FDR). An FDR not exceeding 5% was regarded as significant. For sensitivity analysis, two alternative risk adjustment models were tested, with either a four-category

grouping of procedures, or with diagnosis categories, instead of the 13-category procedure grouping. In addition, a model with the four Norwegian hospital regions was also estimated.

Hospital volume, modelled by splines[35], was tested for inclusion in the model. We also performed this test after exclusion of hospitals with zero reclosures.

Finally, the hospital specific effects were modelled as a mixture of two normal distributions. The expectation-maximization (EM) algorithm was used, taking into account the estimation variances. The mixture model yielded estimates of the quartiles of the hospital odds ratios and the scaled interquartile range (normalized by dividing by 1.349, to give the standard deviation in the case of a normal distribution) was computed as a measure of spread among hospitals. Bootstrapping of the mixture model was used to find a 95% confidence interval for the scaled interquartile range.

Risk adjustment

The following case-mix variables were included as candidates in the stepwise regression: age, gender, indicators for the individual Charlson comorbidities, number of previous hospital admissions two years prior to current admission, and whether the episode was acute or elective. A linear trend in admission year was also included. Age was modelled by natural splines with knots at the median and quartiles.[35] Based on previous studies of risk factors[9 17], procedures were categorized into 13 types, according to the body system or organ involved. The effects of operation types were normalized to have zero sum on the logistic scale.

For a quality indicator, only characteristics of the patient when entering the hospital, are meaningful risk adjustment variables. No data were available for smoking, obesity or other patient or case characteristics such as nutritional status. There was no information about operation urgency beyond the status of the hospital admission or episode as elective or acute.

Patient and Public Involvement

Patients were not involved in the planning, conduct or analysis of this study. The policy of the Norwegian Institute of Public health is to publish hospital quality indicators, when they have been successfully validated.

RESULTS

The initial data set comprised 96 102 episodes with laparotomy and 1 909 with a reclosure operation. After restricting data to reclosures paired with a laparotomy within 30 days, 1 580 reclosures remained. After exclusions for pregnancy, childbirth and puerperium or immunocompromised state, age and LOS, 78 299 laparotomies remained. Lastly, hospitals with less than 10 laparotomies were excluded, yielding a final data set with 66 925 unique patients, 78 086 laparotomies and 1 477 reclosures from 47 hospitals. Descriptive statistics for the dataset are shown in Table 1. The operation types are tabulated in the online Supplement.

Table 1. Descriptive statistics for final data set

	PWD	**No PWD**
Age, years, median (quartiles)	69 (61-78)	65 (51-75)
Gender, females, n (%)	517 (35)	43 094 (56)
Acute laparotomy episode, n (%)	657 (44)	26 381 (34)
Main diagnosis for reclosure episode coded as PWD, n (%)	45 (3.1)	—
Main diagnosis for reclosure episode coded as deep wound infection, n (%)	274 (19)	—
Hospital type for laparotomy episodes		
Regional, n (%)	545 (37)	28 104 (37)
Large with acute function, n (%)	810 (55)	40 291 (53)
Small with acute function, n (%)	122 (8.3)	8 214 (11)
Comorbidities		
Diabetes with complications, n (%)	18 (1.2)	893 (1.2)
Chronic pulmonary disease, n (%)	196 (13)	5 147 (6.7)
Renal disease, n (%)	66 (4.5)	2 716 (3.5)

30 day mortality (laparotomy episode), %	67 (4.5)	2 668 (3.5)
Length of stay (LOS) laparotomy episode, days, median (quartiles)	19 (11-29)	7.4 (4.4-13)
Reclosure and matched laparotomy in same episode, n (%)	1 211 (82)	—
Converted from laparoscopy or endoscopy to laparotomy, n (%)	12 (0.81)	578 (0.75)
Robot assistance in laparotomy, n (%)	3 (0.2)	404 (0.53)

From 2011 to 2015, the annual volume of laparotomies decreased somewhat, from 16 730 to 14 419, while the proportion of acute laparotomies remained stable at around 35%.

The overall rate of PWD for the five-year period was 1.89%. Crude PWD rates varied from 0% to 5.1% among hospitals. After risk adjustment, the range was 0.1% - 5.4%. Table 2 shows the odds ratios of the final logistic regression model. No interactions were included. The model showed good fit according to the modified Hosmer-Lemeshow test[36] (p=0.53) and good predictive ability, with an area under the operating characteristic (c-statistic) of 0.73.

Table 2. Final multivariate logistic model for risk adjustment

Variable	**Adjusted odds ratio**	**(95% confidence interval)**
Year of admission	0.93	(0.90-0.96)
Age, spline function		
40 (reference)	1.00	
50	1.37	(1.25-1.49)
60	1.97	(1.65-2.36)
70	2.39	(1.97-2.90)
Gender		
Female (reference)	1	
Male	2.42	(2.16-2.72)
Elective laparotomy episode (reference)	1	
Acute laparotomy episode	1.36	(1.21-1.52)
Chronic pulmonary disease	1.72	(1.47-2.01)
Operation type[a]		
Exploratory laparotomy	2.40	(1.78-3.24)
Hernia (diaphragmal)	2.57	(1.37-4.81)
Thoracoabdominal aorta	2.08	(0.85-5.09)
Gastrointestinal tract	2.04	(1.69-2.46)
Liver	1.14	(0.69-1.87)

Biliary tract	0.12	(0.05-0.28)
Pancreas	0.79	(0.40-1.58)
Spleen	1.20	(0.45-3.24)
Other digestive system	1.46	(1.03-2.07)
Kidney	0.09	(0.03-0.28)
Other urinary and male genital organs	0.52	(0.37-0.71)
Female genital organs	1.43	(1.06-1.92)
Peripheral vascular surgery	1.21	(0.93-1.57)
More than one type of surgery[b]	2.58	(2.12-3.15)
Hospital		
Scaled interquartile range	0.30	(0.23-0.34)

[a] Odds ratios for operation type is scaled to have geometric mean

[b] Not counting exploratory laparotomy

In Figure 1, risk-adjusted PWD rates are shown for each hospital, plotted versus laparotomy volume and hospital type.

After significance testing, we identified three hospitals with higher PWD and none with lower PWD than average, when correcting for multiple testing. Without multiple test correction, one additional hospital with high PWD was found to be marginally significant (p=0.053).

In the alternative model including volume, the PWD increased with yearly laparotomy volume from a very low level up to 120 laparotomies per year, after which it remained fairly constant, see Figure 1. The effect of volume was significant (p<0.001), also after exclusion of the four smallest volume hospitals with zero reclosures (p=0.008). Hospital type coincided almost completely with a grouping of hospitals by volume, and was therefore not tested separately. There was significant variation among regions (p<0.001), with the Northern region having the highest and the South-Eastern region the lowest rates. Details can be found in the online supplement. Using diagnosis categories or aggregated operation type as risk adjustment variables resulted in very small changes in risk adjusted PWD rates.

DISCUSSION

We have studied wound dehiscence after laparotomy, as a quality indicator based on the OECD specification, and found that it discriminated between Norwegian hospitals. The indicator was risk adjusted for differences in age, gender, comorbidity and type of surgery, and showed little sensitivity to changes in the set of risk adjustment variables. The overall PWD rate was 1.89%. After risk adjustment, the hospitals' PWD rate varied between 0.1% and 5.4%. Laparotomy volume and type of hospital had little effect on the PWD rate, except for hospitals with very low volume. Advanced age, male gender, chronic pulmonary disease, and emergency laparotomy were all significant risk factors for PWD. There were significant PWD differences according to the organ system targeted. The overall rate of PWD showed a small but statistically significant decline over the observation period 2011-2015. The relatively large variation of PWD rates between hospitals, after correction for patient characteristics and operation type, indicates possible variation in the quality of healthcare among hospitals. This may be due to variation in surgical technique and perioperative care, as well as the handling of postoperative complications, such as wound infection, which is known to be a risk factor for PWD.[17] We found PWD rates well within the range reported in international studies.[9 13 14 17 21 37 38] Also, the risk factors identified are in accordance with previous studies, albeit limited to administrative data. Laparotomy volume has negligible effect apart from the few hospitals with very low volume. A Japanese study reported a similar conclusion, while volume was found to have effect in US hospitals.[39 40] The effect is likely a result of the types of operations performed at the low-volume hospitals, compared with the other hospitals.

Our study is based on complete data from all Norwegian hospitals performing laparotomies. It was possible to track patients during transfers and reoperations at different hospitals. To the best of our knowledge, no similar study has been performed. NPR, the data source, has been validated for several disease categories with respect to identification of cases based on diagnoses and/or

procedures, and found to have a very high degree of completeness, compared to Norwegian national medical quality registries.[41-44] At the time of writing, the completeness of NPR, after 24 registries have been studied, ranges from 83.5% to 99.8%.[24]

We cannot exclude a residual imbalance in case mix, affecting PWD through e.g. smoking or obesity, which are known risk factors. There is regional variation in the prevalence of smoking and obesity in Norway.[45] Obesity is more prevalent in Northern Norway, where PWD rates are somewhat higher. However, in some other areas where obesity is less prevalent, the rates are similar. There is no consistent correspondence between the known variation in smoking among counties and PWD rates. Some surgical procedures are performed only at regional hospitals, and it is therefore possible that selection effects are present. In that case, one would expect larger changes in PWD rates after risk adjustment for operation type, which was not found. One potential source of error in our study is the completeness and correctness of coding in the NPR, particularly the coding of reclosure operations. The risk adjustment depends on data from previous hospitalization and may not capture all comorbidities. Moreover, selection effects cannot not be ruled out. Differing policies for operations on patients with known risk factors, e.g. obesity or smoking, would likely cause variation in PWD rates. Patients who die before reoperation or are managed by other means will not be registered. We believe that this applies to very few patients and would not influence our results. No attempt was made to identify main operation or operation intent, as this would require a classification effort outside the scope of the present study.

Previous studies have shown that the quality indicator has high positive predictive value, but only moderate sensitivity.[10 46 47]Since we have used specific wound reclosure codes, similar to those used in previous studies, we expect a high positive predictive value in Norway as well. Conceivably, the sensitivity depends on the coding system, in particular the various alternative codes related to complications. Sensitivity in Norway may thus differ from that of other healthcare systems. A recent retrospective medical record study from neighbouring Sweden reports that 86.9% of wound

dehiscences were reoperated.[38] Norway has an activity-based system for financing hospitals, which is an incentive to report all reclosure operations.

Conclusions

Among Norwegian hospitals, there is a significant variation in PWD rate after laparotomies that cannot be explained by operation type, age, comorbidity or whether the admission was elective or acute. This warrants further investigation into possible causes, such as patient related factors, surgical technique, perioperative procedures or handling of complications, e.g. wound infections. Some of these factors are known to be amenable.[20 48] The relatively large between-hospital variation found in the present study is an indication of potential for improvement. The risk adjusted PWD rate after laparotomy is a candidate for use as a quality indicator for Norwegian hospitals, and will make it possible to identify hospitals with apparent quality problems. To achieve sufficient discrimination, however, five-year data are desirable, making it more difficult to monitor changes in hospital performance resulting from quality improvement efforts. It lies outside the scope of the present study to perform a comprehensive validation of the PWD rate as a quality indicator suitable for public reporting. There are uncertainties and potential biases in the indicator, implying that it must be regarded as a signal for follow-up within hospitals, rather than giving a final verdict of inferior or superior quality. For reporting on surgical quality, several indicators should be used to give a balanced view of the different aspects of quality and patient safety.

FOOTNOTES

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Competing interests

The authors have no competing interests.

Authors' contributions

AKL and OT conceived the study. DTK, TMH, OT, and SH participated in data preparation. OT, SH and AKL contributed to the analysis. OT helped draft the manuscript. JH was responsible for the statistical analysis and final manuscript. All authors revised and approved the final manuscript.

Ethics approval

The study was approved by the Norwegian Directorate of Health and the Norwegian Data Protection Authority.

Data sharing

The data set contains indirectly identifiable personal data, and cannot be shared without express permission from the Norwegian Patient Registry. For further information, contact the corresponding author.

Figure 1. Risk adjusted PWD rates versus yearly laparotomy volume, by hospital type. Trend curve is obtained by smoothing the scatterplot. Significance testing is adjusted for multiple comparisons

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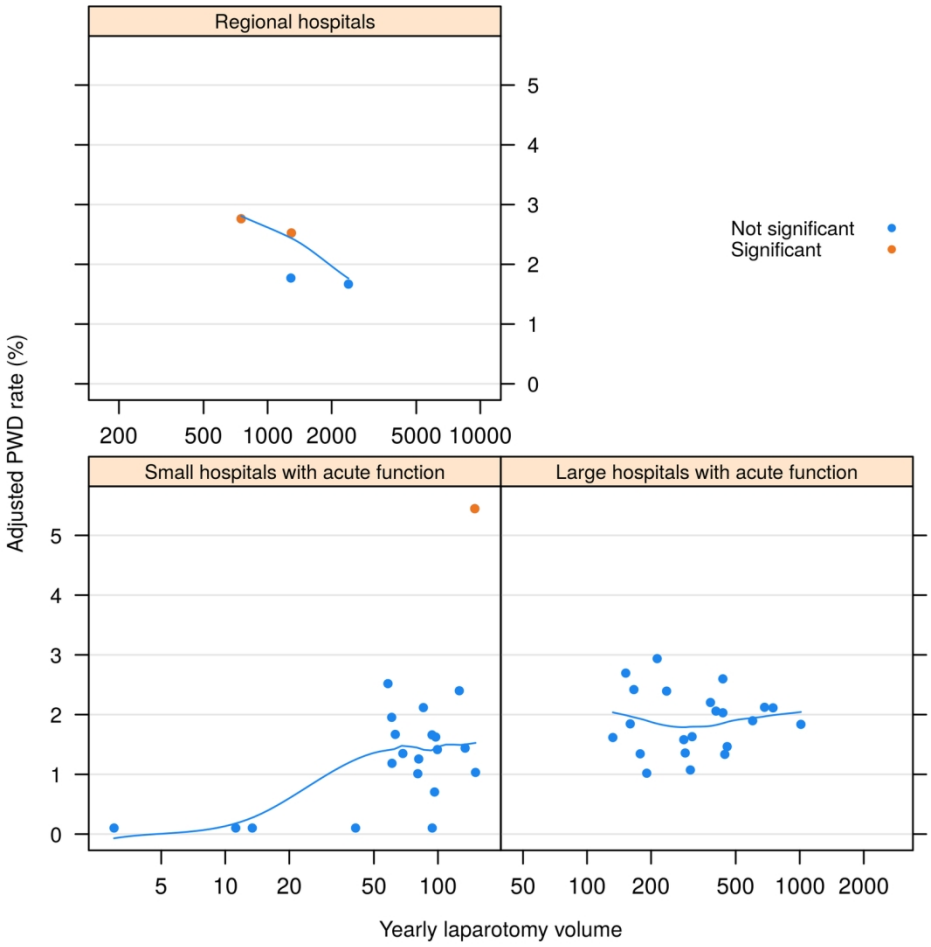

Figure 1. Risk adjusted PWD rates versus yearly laparotomy volume, by hospital type. Trend curve is obtained by smoothing the scatterplot. Significance testing is adjusted for multiple comparisons

149x149mm (300 x 300 DPI)

Online supplement

Table 1. Hospital types

Hospital type	Number
Small hospitals with acute function	21
Large hospitals with acute function	22
Regional hospitals	4

Table 2. Laparotomy cases after operation type (primary episode)

Operation type	Frequency, n (%)
Gastrointestinal tract	30 404 (38.9)
More than one type of surgery[a]	14 051 (18.0)
Female genital organs	10 720 (13.7)
Other urinary and male genital organs	6 536 (8.4)
Peripheral vascular surgery	4 628 (5.9)
Biliary tract	2 739 (3.5)
Other digestive system	2 226 (2.9)
Kidney	2 152 (2.8)
Exploratory laparotomy	2 061 (2.6)
Liver	1 122 (1.4)
Pancreas	775 (1.0)
Hernia (diaphragmal)	274 (0.4)
Spleen	248 (0.3)
Thoracoabdominal aorta	150 (0.2)

[a]Not counting exploratory laparotomy

Table 3. Effect of hospital region, after risk adjustment. Odds ratio standardized to have geometric mean one.

Hospital region	Adjusted odds ratio (95% confidence interval)
South-Eastern Norway Region	0.85 (0.78 - 0.92)
Central Norway Region	0.99 (0.89 - 1.10)
Western Norway Region	1.06 (0.96 - 1.17)
Northern Norway Region	1.13 (1.001 - 1.27)

Diagnoses

Table 4. ICD-10 diagnosis codes contained in MDC 14 (Pregnancy, childbirth, and puerperium)

Code	Title
A34	Obstetrical tetanus
F53.0	Mild mental and behavioural disorders associated with the puerperium, not elsewhere classified
F53.1	Severe mental and behavioural disorders associated with the puerperium, not elsewhere classified
F53.8	Other mental and behavioural disorders associated with the puerperium, not elsewhere classified
F53.9	Puerperal mental disorder, unspecified
Oxx.x	Pregnancy, childbirth and puerperium
Z32.0	Pregnancy, not (yet) confirmed
Z32.1	Pregnancy confirmed
Z33	Pregnant state, incidental
Z34.0	Supervision of normal first pregnancy
Z34.8	Supervision of other normal pregnancy
Z34.9	Supervision of normal pregnancy, unspecified
Z35.0	Supervision of pregnancy with history of infertility
Z35.1	Supervision of pregnancy with history of abortive outcome
Z35.2	Supervision of pregnancy with other poor reproductive or obstetric history
Z35.3	Supervision of pregnancy with history of insufficient antenatal care
Z35.4	Supervision of pregnancy with grand multiparity
Z35.5	Supervision of elderly primigravida
Z35.6	Supervision of very young primigravida
Z35.8	Supervision of other high-risk pregnancies
Z35.9	Supervision of high-risk pregnancy, unspecified
Z36.0	Antenatal screening for chromosomal anomalies
Z36.1	Antenatal screening for raised alphafetoprotein level
Z36.2	Other antenatal screening based on amniocentesis
Z36.3	Antenatal screening for malformations using ultrasound and other physical methods
Z36.4	Antenatal screening for fetal growth retardation using ultrasound and other physical methods
Z36.5	Antenatal screening for isoimmunization
Z36.8	Other antenatal screening
Z36.9	Antenatal screening, unspecified
Z37.0	Single live birth
Z37.1	Single stillbirth
Z37.2	Twins, both liveborn
Z37.3	Twins, one liveborn and one stillborn
Z37.4	Twins, both stillborn
Z37.5	Other multiple births, all liveborn
Z37.6	Other multiple births, some liveborn
Z37.7	Other multiple births, all stillborn
Z37.9	Outcome of delivery, unspecified
Z39.0	Care and examination immediately after delivery
Z39.1	Care and examination of lactating mother
Z39.2	Routine postpartum follow-up
Z64.0	Problems related to unwanted pregnancy

Table 5. ICD-10 diagnosis codes for immunocompromised state

Code	Title
B20.0	HIV disease resulting in mycobacterial infection
B20.1	HIV disease resulting in other bacterial infections
B20.2	HIV disease resulting in cytomegaloviral disease
B20.3	HIV disease resulting in other viral infections
B20.4	HIV disease resulting in candidiasis
B20.5	HIV disease resulting in other mycoses
B20.6	HIV disease resulting in Pneumocystis carinii pneumonia
B20.7	HIV disease resulting in multiple infections
B20.8	HIV disease resulting in other infectious and parasitic diseases
B20.9	HIV disease resulting in unspecified infectious or parasitic disease
B21.0	HIV disease resulting in Kaposi's sarcoma
B21.1	HIV disease resulting in Burkitt's lymphoma
B21.2	HIV disease resulting in other types of non-Hodgkin's lymphoma
B21.3	HIV disease resulting in other malignant neoplasms of lymphoid, haematopoietic and related tissue
B21.7	HIV disease resulting in multiple malignant neoplasms
B21.8	HIV disease resulting in other malignant neoplasms
B21.9	HIV disease resulting in unspecified malignant neoplasm
B22.0	HIV disease resulting in encephalopathy
B22.1	HIV disease resulting in lymphoid interstitial pneumonitis
B22.2	HIV disease resulting in wasting syndrome
B22.7	HIV disease resulting in multiple diseases classified elsewhere
B23.1	HIV disease resulting in (persistent) generalized lymphadenopathy
B23.2	HIV disease resulting in haematological and immunological abnormalities, not elsewhere classified
B23.8	HIV disease resulting in other specified conditions
B24	Unspecified human immunodeficiency virus [HIV] disease
B59	Pneumocystosis
D47.1	Chronic myeloproliferative disease
D70	Agranulocytosis
D71	Functional disorders of polymorphonuclear neutrophils
D72.0	Genetic anomalies of leukocytes
D80.0	Hereditary hypogammaglobulinaemia
D80.1	Nonfamilial hypogammaglobulinaemia
D80.2	Selective deficiency of immunoglobulin A [IgA]
D80.3	Selective deficiency of immunoglobulin G [IgG] subclasses
D80.4	Selective deficiency of immunoglobulin M [IgM]
D80.5	Immunodeficiency with increased immunoglobulin M [IgM]
D80.6	Antibody deficiency with near-normal immunoglobulins or with hyperimmunoglobulinaemia
D80.7	Transient hypogammaglobulinaemia of infancy
D80.8	Other immunodeficiencies with predominantly antibody defects
D80.9	Immunodeficiency with predominantly antibody defects, unspecified
D81.0	Severe combined immunodeficiency [SCID] with reticular dysgenesis
D81.1	Severe combined immunodeficiency [SCID] with low T- and B-cell numbers
D81.2	Severe combined immunodeficiency [SCID] with low or normal B-cell numbers
D81.3	Adenosine deaminase [ADA] deficiency
D81.4	Nezelof's syndrome
D81.5	Purine nucleoside phosphorylase [PNP] deficiency
D81.6	Major histocompatibility complex class I deficiency
D81.7	Major histocompatibility complex class II deficiency
D81.8	Other combined immunodeficiencies
D81.9	Combined immunodeficiency, unspecified
D82.0	Wiskott-Aldrich syndrome
D82.1	Di George's syndrome

Code	Title
D82.2	Immunodeficiency with short-limbed stature
D82.3	Immunodeficiency following hereditary defective response to Epstein-Barr virus
D82.4	Hyperimmunoglobulin E [IgE] syndrome
D82.8	Immunodeficiency associated with other specified major defects
D82.9	Immunodeficiency associated with major defect, unspecified
D83.0	Common variable immunodeficiency with predominant abnormalities of B-cell numbers and function
D83.1	Common variable immunodeficiency with predominant immunoregulatory T-cell disorders
D83.2	Common variable immunodeficiency with autoantibodies to B- or T-cells
D83.8	Other common variable immunodeficiencies
D83.9	Common variable immunodeficiency, unspecified
D84.0	Lymphocyte function antigen-1 [LFA-1] defect
D84.1	Defects in the complement system
D84.8	Other specified immunodeficiencies
D84.9	Immunodeficiency, unspecified
D89.8	Other specified disorders involving the immune mechanism, not elsewhere classified
D89.9	Disorder involving the immune mechanism, unspecified
E40	Kwashiorkor
E41	Nutritional marasmus
E42	Marasmic kwashiorkor
E43	Unspecified severe protein-energy malnutrition
I12.0	Hypertensive renal disease with renal failure
I13.1	Hypertensive heart and renal disease with renal failure
I13.2	Hypertensive heart and renal disease with both (congestive) heart failure and renal failure
K91.2	Postsurgical malabsorption, not elsewhere classified
N18.0	End-stage renal disease
N18.5	Chronic kidney disease, stage 5
N18.8	Other chronic renal failure
T86.0	Bone-marrow transplant rejection
T86.1	Kidney transplant failure and rejection
T86.2	Heart transplant failure and rejection
T86.3	Heart-lung transplant failure and rejection
T86.4	Liver transplant failure and rejection
T86.8	Failure and rejection of other transplanted organs and tissues
T86.9	Failure and rejection of unspecified transplanted organ and tissue
Y83.0	Surgical Operation with transplant of whole organ or tissue
Z49.0	Preparatory care for dialysis
Z49.1	Extracorporeal dialysis
Z49.2	Other dialysis
Z94.0	Kidney transplant status
Z94.1	Heart transplant status
Z94.2	Lung transplant status
Z94.3	Heart and lungs transplant status
Z94.4	Liver transplant status
Z94.8	Other transplanted organ and tissue status
Z94.9	Transplanted organ and tissue status, unspecified

Operations

Procedure codes for laparotomy and operation types. Laparotomy codes are the total of codes in tables 6-19. Note that a last code digit of 0, 3 or 6 signifies an open or other non-endoscopic operation or procedure, except for peripheral vascular surgery.

Table 6. NCSP-N codes for reclosure procedures

Code	Title
JWA00	Repair of wound dehiscence in gastroenterological surgery
KWA00	Repair of wound dehiscence in urological surgery
LWA00	Repair of wound dehiscence in gynaecological surgery
PWA00	Repair of wound dehiscence in surgery of peripheral vessels and lymphatic system

Table 7. NCSP-N code for exploratory laparotomy and opening of abdominal cavity

Code	Title
JAA00	Incision of abdominal wall
JAH00	Laparotomy
JAH20	Staging laparotomy
JAH30	Laparostomy
JAH33	Opening of laparostomy
JAH40	Thoracolaparotomy

Table 8. NCSP-N codes for diaphragmal hernia repair

Code	Title
JBB00	Repair of paraoesophageal hernia
JBB10	Repair of congenital diaphragmatic hernia
JBB96	Repair of other diaphragmatic hernia
JBC00	Gastro-oesophageal antireflux operation

Table 9. NCSP-N codes for repair of thoracoabdominal aorta

Code	Title
FCD00	Suture of thoracoabdominal aorta
FCD10	Reinforcement of thoracoabdominal aorta using suture
FCD30	Repair of thoracoabdominal aorta using patch
FCD40	Partial resection and suture of thoracoabdominal aorta
FCD50	Resection and reconstruction of thoracoabdominal aorta using tube graft
FCD60	Resection of thoracoabdominal aorta and reimplantation of branches
FCD70	Bypass of thoracoabdominal aorta using tube graft
FCD80	Removal of foreign body from thoracoabdominal aorta
FCD96	Other repair of thoracoabdominal aorta

Table 10. NCSP-N codes for procedures on the gastrointestinal tract: oesophagus, stomach and intestines

Code	Title
JCB00	Oesophagostomy
JCC00	Transhiatal partial oesophagectomy without interposition
JCC10	Transthoracic partial oesophagectomy without interposition
JCC20	Transhiatal partial oesophagectomy with interposition of intestine
JCC30	Transthoracic partial oesophagectomy with interposition of intestine
JCC96	Other partial oesophagectomy
JCD00	Subcutaneous anastomosis of oesophagus without interposition
JCD03	Subcutaneous anastomosis of oesophagus with interposition of intestine
JCD10	Intrathoracic anastomosis of oesophagus without interposition
JCD13	Intrathoracic oesophageal anastomosis with interposition of intestine
JCD20	Transsection of oesophagus
JCD96	Other anastomosis of oesophagus without resection
JCE00	Suture of oesophagus
JCE10	Plastic repair of stenosis of cardia
JCE20	Cardiomyotomy
JCE30	Repair of oesophageal atresia or congenital tracheo-oesophageal fistula
JCE33	Closure of acquired tracheo-oesophageal or broncho-oesophageal fistula
JCE40	Reconstruction of oesophagus using flap
JCE50	Reconstruction of oesophagus using free microvascular graft of intestine
JCE96	Other reconstruction of oesophagus
JCF00	Insertion of oesophageal stent
JCW96	Other operation on oesophagus
JDA00	Gastrotomy
JDA60	Closure of perforated ulcer of stomach
JDA63	Local excision of lesion of stomach
JDB00	Gastrostomy
JDB10	Percutaneous gastrostomy
JDC00	Partial gastrectomy and gastroduodenostomy
JDC10	Partial gastrectomy and gastrojejunostomy
JDC20	Partial gastrectomy and Roux-en-Y reconstruction
JDC30	Partial gastrectomy with interposition of jejunum
JDC40	Partial gastrectomy and oesophagogastrostomy
JDC96	Partial gastrectomy with other reconstruction
JDD00	Total gastrectomy and Roux-en-Y oesophagojejunostomy
JDD96	Total gastrectomy with other reconstruction
JDE00	Gastrojejunostomy
JDE10	Conversion of gastrojejunostomy to Roux-en-Y anastomosis
JDE20	Conversion of gastrojejunostomy to gastroduodenostomy with interposition of jejunum
JDE96	Other anastomosis of stomach without concurrent gastrectomy
JDF00	Gastroplasty

Code	Title
JDF10	Gastric bypass
JDF20	Gastric banding
JDF96	Other bariatric operation on stomach
JDG00	Truncal vagotomy
JDG10	Proximal gastric vagotomy
JDG96	Other vagotomy
JDH00	Duodenotomy
JDH40	Duodenostomy on duodenal bulb
JDH50	Local excision of lesion of duodenal bulb
JDH60	Pyloromyotomy
JDH63	Pyloroplasty
JDH70	Closure of perforated ulcer of duodenum
JDW96	Other operation on stomach or duodenum
JEA00	Appendectomy
JEA10	Appendectomy with drainage
JEW96	Other operation on appendix
JFA00	Enterotomy
JFA10	Colotomy
JFA16	Biopsy of wall of colon without colotomy
JFA60	Stricturoplasty in small intestine
JFA63	Stricturoplasty in colon
JFA70	Suture of small intestine
JFA73	Excision of lesion of small intestine
JFA76	Closure of fistula of small intestine
JFA80	Suture of colon
JFA83	Excision of lesion of colon
JFA86	Closure of fistula of colon
JFA96	Other local operation on intestine
JFB00	Partial resection of small intestine
JFB10	Reversal of segment of small intestine
JFB13	Plastic repair of small intestine with lengthening
JFB20	Ileocaecal resection
JFB30	Right hemicolectomy
JFB33	Other resection comprising small intestine and colon
JFB40	Resection of transverse colon
JFB43	Left hemicolectomy
JFB46	Resection of sigmoid colon
JFB50	Other resection of colon
JFB53	Resection of sigmoid colon sigmoideum with partial resection of rectum
JFB60	Resection of sigmoid colon with end colostomy
JFB63	Other resection of colon with proximal colostomy and closure of distal stump
JFB96	Other partial excision of intestine
JFC00	Entero-enterostomy
JFC10	Ileotransversostomy

Code	Title
JFC20	Other enterocolostomy
JFC30	Colo-colostomy
JFC40	Ileorectostomy
JFC50	Colorectostomy
JFD00	Jejunoileal bypass
JFD03	Duodenoileal bypass with biliopancreatic diversion
JFD10	Revision of jejunoileal bypass
JFD13	Revision of duodenoileal bypass
JFD20	Restoration of continuity after jejunoileal bypass
JFD23	Restoration of continuity after duodenoileal bypass
JFD96	Other intestinal bypass operation
JFE00	Transplantation of small intestine
JFE96	Other operation relating to transplantation of small intestine
JFF00	Catheter enterostomy
JFF10	Loop enterostomy
JFF13	Terminal enterostomy
JFF16	Conversion of ileoanal anastomosis to ileostomy
JFF20	Caecostomy
JFF23	Transversostomy
JFF26	Sigmoidostomy
JFF30	Other colostomy
JFF40	Appendicostomy
JFF50	Exteriorisation of loop of colon without opening
JFF60	Opening of exteriorised loop of colon
JFF96	Other exteriorisation of intestine or creation of intestinal stoma
JFG00	Closure of loop enterostomy without resection
JFG10	Closure of loop colostomy without resection
JFG20	Closure of enterostomy with resection of exteriorised loop
JFG23	Closure of terminal enterostomy with anastomosis to small intestine
JFG26	Closure of terminal enterostomy with anastomosis to colon
JFG30	Closure of colostomy with resection of exteriorised loop
JFG33	Closure of terminal colostomy with anastomosis to colon
JFG36	Closure of terminal colostomy with anastomosis to rectum
JFG40	Revision of enterostomy or colostomy without laparotomy
JFG50	Laparotomy with revision of enterostomy or colostomy
JFG53	Revision of ileal pelvic pouch
JFG56	Revision of colonic pelvic pouch
JFG60	Conversion of conventional ileostomy to continent ileostomy
JFG70	Conversion of continent ileostomy to conventional ileostomy
JFG73	Excision of ileal pelvic pouch
JFG76	Excision of colonic pelvic pouch with colorectal or coloanal anastomosis
JFG80	Excision of ileal pouch with construction of new continent ileostomy
JFG83	Excision of colonic pelvic pouch and construction of new pouch
JFG86	Excision of ileal pelvic pouch and construction of new pouch

Code	Title
JFG96	Other operation on intestinal stoma or pouch
JFH00	Total colectomy and ileorectal anastomosis
JFH10	Total colectomy and ileostomy
JFH20	Proctocolectomy and ileostomy
JFH30	Total colectomy, mucosal proctectomy and ileoanal anastomosis without ileostomy
JFH33	Total colectomy, mucosal proctectomy, ileoanal anastomosis and ileostomy
JFH40	Proctocolectomy and continent ileostomy
JFH96	Other total colectomy
JFJ00	Coecopexy
JFJ96	Other enteropexy or colopexy
JFK00	Division of adhesive band in intestinal obstruction
JFK10	Freeing of adhesions in intestinal obstruction
JFK20	Freeing of adhesions and plication of small intestine
JFK96	Other operation on adhesions in intestinal obstruction
JFL00	Open reduction of intussusception of intestine
JFL10	Laparotomy and manipulation of obstructed intestine
JFL20	Laparotomy and manipulation of impacted material
JFL96	Other operation for intestinal obstruction without resection or freeing of adhesions
JFW96	Other operation on intestine
JGA00	Proctotomy
JGA60	Suture of rectum
JGA70	Proctotomy and excision of lesion of rectum
JGA96	Other proctotomy or local operation on rectum
JGB00	Partial proctectomy and colorectal or coloanal anastomosis
JGB03	Partial proctectomy with partial excision of mesorectum
JGB06	Total mesorectal excision
JGB10	Partial proctectomy and end colostomy
JGB20	Partial rectosigmoidectomy and abdominoperineal pull-through anastomosis
JGB30	Abdominoperineal excision of rectum
JGB33	Abdominoperineal excision of rectum and intersphincter resection
JGB36	Wide excision of rectum
JGB40	Excision of rectum and end ileostomy
JGB50	Mucosal proctectomy and ileoanal anastomosis
JGB60	Excision of rectum and ileoanal anastomosis
JGB96	Other proctectomy or excision of rectum
JGC00	Rectopexy
JGC30	Excision and suture of rectal mucosa with imbrication of muscular layer
JGC96	Other reconstructive operation on rectum
JGW96	Other operation on rectum

Table 11. NCSP-N codes for procedures on the liver

Code	Title
JJA00	Exploration of liver
JJA10	Hepatotomy
JJA20	Open biopsy of liver
JJA23	Open needle biopsy of liver
JJA30	Fenestration of cyst of liver
JJA40	Excision of lesion of liver
JJA43	Destruction of lesion of liver
JJA50	Suture of liver
JJA96	Other local operation on liver
JJB00	Wedge resection of liver
JJB10	Atypical resection of liver
JJB20	Excision of single segment of liver
JJB30	Excision of two segments of liver
JJB40	Excision of segments II, III and IV of liver
JJB50	Excision of segments V, VI, VII and VIII of liver
JJB53	Excision of segments IV,V, VI, VII and VIII of liver
JJB60	Other excision of three or more segments of liver
JJB96	Other resection of liver
JJC00	Allogenic transplantation of liver
JJC10	Allogenic partial transplantation of liver
JJC20	Allogenic partial transplantation of liver from living donor
JJC30	Xenogenic transplantation of liver
JJC40	Xenogenic partial transplantation of liver
JJC50	Resection of transplanted liver
JJC60	Total excision of transplanted liver
JJC96	Other transplantation of liver or related operation
JJW96	Other operation on liver

Table 12. NCSP-N codes for procedures on biliary tract

Code	Title
JKA00	Cholecystotomy
JKA10	Cholecystostomy
JKA20	Cholecystectomy
JKA96	Other operation on gallbladder
JKB00	Incision of bile duct
JKB20	Intraoperative cholangioscopy
JKB30	Percutaneous transhepatic biliary drainage
JKB40	Suture of bile duct
JKB96	Other incision or related operation on bile duct
JKC00	Incision of bile duct and local excision of lesion
JKC10	Partial excision and anastomosis of bile duct

Code	Title
JKC20	Partial excision of bile duct and anastomosis to duodenum
JKC30	Partial excision of bile duct and anastomosis to jejunum
JKC40	Partial excision of right or left hepatic duct and anastomosis to jejunum
JKC50	Excision of papilla of Vater and anastomosis of bile duct to duodenum or jejunum
JKC96	Other excision of bile duct
JKD00	Anastomosis of gallbladder to jejunum
JKD10	Anastomosis of bile duct to duodenum
JKD20	Anastomosis of bile duct to jejunum
JKD30	Extrahepatic anastomosis of right or left hepatic duct to jejunum
JKD40	Anastomosis of intrahepatic bile duct to jejunum
JKD50	Hepatoportoenterostomy
JKD96	Other biliodigestive anastomosis without excision
JKE00	Transduodenal papillotomy
JKE06	Transduodenal sphincteroplasty
JKE96	Other transduodenal open operation on bile duct or ampulla of Vater
JKF00	Excision of cystic duct
JKF96	Other secondary operation on biliary tract
JKW96	Other operation on biliary tract

Table 13. NCSP-N codes for procedures on the pancreas

Code	Title
JLA00	Exploration of pancreas
JLA10	Biopsy of pancreas
JLB00	Incision of pancreas
JLB10	Pancreaticolithotomy
JLB96	Other incision, drainage or dilatation of pancreas
JLC00	Excision of lesion of pancreas
JLC10	Distal pancreatectomy
JLC20	Total pancreatectomy
JLC30	Pancreatoduodenectomy
JLC40	Total pancreatoduodenectomy
JLC50	Atypical pancreatectomy
JLC96	Other pancreatectomy
JLD00	Pancreaticojejunostomy
JLD10	Anastomosis of pancreatic pseudocyst to stomach
JLD20	Anastomosis of pancreatic pseudocyst to jejunum
JLE00	Allogenic total transplantation of pancreas with pancraticocystostomy
JLE03	Allogenic total transplantation of pancreas with pancreaticoenterostomy
JLE10	Allogenic segmental transplantation of pancreas
JLE16	Allogenic segmental transplantation of pancreas from living donor
JLE20	Allogenic islet cell transplantation
JLE30	Xenogenic islet cell transplantation

Code	Title
JLE40	Total excision of transplanted pancreas
JLE50	Occlusion of duct of transplanted pancreas
JLE56	Conversion of pancreaticocystostomy to pancreaticoenterostomy
JLE96	Other transplantation of pancreas or related operation
JLW96	Other operation on pancreas

Table 14. NCSP-N codes for procedures on the spleen

Code	Title
JMA00	Partial splenectomy
JMA10	Transabdominal total splenectomy
JMA20	Transthoracic total splenectomy
JMB00	Biopsy of spleen
JMB10	Repair of spleen
JMW96	Other operation on spleen

Table 15. NCSP-N codes for other digestive system procedures

Code	Title
JAA10	Excision of lesion of abdominal wall
JAA13	Wide excision of extensive necrotising conditions of abdominal wall
JAA96	Other local operation on abdominal wall
JAK00	Laparotomy and drainage of peritoneal cavity
JAK03	Laparotomy and peritoneal irrigation
JAK10	Laparotomy and insertion of peritoneal dialysis catheter
JAL00	Biopsy of peritoneum
JAL10	Laparotomy and removal of foreign body
JAL20	Excision or destruction of lesion of peritoneum
JAL23	Excision of local lesion of pelvic wall
JAL30	Omentectomy
JAL50	Intraabdominal revision of shunt of ventricle of brain
JAL96	Other excision of lesion of peritoneum
JAM00	Transposition of omentum
JAM10	Operation for malrotation of intestine
JAN00	Creation of peritoneovenous shunt
JAN10	Revision of peritoneovenous shunt
JAN20	Removal of peritoneovenous shunt
JAP00	Freeing of adhesions in the peritoneal cavity
JAQ00	Extensive excision of peritoneum
JAQ10	Intraoperative hypertermic chemotherapeutic perfusion of abdominal cavity
JAW96	Other operation on abdominal wall, peritoneum, mesentery or omentum
JBA00	Transabdominal repair of diaphragm for rupture

Code	Title
JBA10	Transabdominal biopsy or excision of lesion of diaphragm
JBA20	Transabdominal partial excision of diaphragm
JBW96	Other transabdominal operation on diaphragm or operation for gastro-oesophageal reflux

Table 16. NCSP-N codes for procedures on kidney and pelvis of kidney

Code	Title
KAA00	Exploration of kidney
KAA20	Exploratory nephrotomy
KAA30	Exploratory pyelotomy
KAA96	Other exploration of kidney or pelvis of kidney
KAB00	Biopsy of kidney or pelvis of kidney
KAC00	Nephrectomy
KAC20	Nephroureterectomy
KAD00	Partial nephrectomy
KAD10	Heminephrectomy
KAD40	Partial excision of pelvis of kidney
KAD50	Destruction of tumour of pelvis of kidney
KAD56	Destruction of lesion of renal parenchyma
KAD60	Percutaneous destruction of lesion of renal parenchyma
KAD96	Other partial excision of kidney or pelvis of kidney
KAE00	Nephrolithotomy
KAE10	Pyelolithotomy
KAE96	Other removal of calculus from kidney or pelvis of kidney
KAF00	Removal of foreign body from kidney
KAF10	Removal of foreign body from pelvis of kidney
KAH00	Suture of kidney
KAH10	Suture of pelvis of kidney
KAH30	Pyeloureteroplasty without division of ureteropelvic junction
KAH40	Pyeloureteroplasty with division of ureteropelvic junction
KAH50	Ureterocalyceal anastomosis
KAH70	Freeing of adhesions of ureteropelvic junction
KAH80	Nephropexy
KAH96	Other reconstruction of kidney or pelvis of kidney
KAS00	Autotransplantation of kidney
KAS10	Allogenic transplantation of kidney from cadaver donor
KAS13	Allogenic transplantation of kidney from cadaver donor
KAS20	Allogenic transplantation of kidney from living donor with minimally invasive technique
KAS23	Allogenic transplantation of kidney from living donor with minimally invasive technique
KAS40	Excision of transplanted kidney
KAS50	Nephrocystostomy in transplanted kidney
KAS60	Operation for lymphocele of transplanted kidney
KAS96	Other transplantation of kidney or related procedure
KAW96	Other operation on kidney or pelvis of kidney

Table 17. NCSP-N codes for procedures on other urinary and male genital organs: ureter, bladder, urethra, prostate and seminal vesicles

Code	Title
KBA00	Exploration of ureter
KBA10	Exploratory ureterotomy
KBA96	Other exploration of ureter
KBB00	Biopsy of ureter
KBC00	Ureterectomy
KBD00	Partial excision of ureter
KBD20	Destruction of tumour of ureter
KBD30	Excision of stump of ureter
KBD96	Other partial excision of ureter or destruction of tumour of ureter
KBE00	Ureterolithotomy
KBE96	Other operation for calculus of ureter
KBF00	Removal of foreign body from ureter
KBH00	Suture of ureter
KBH06	Ureteroureterostomy
KBH10	Connection of ureter to contralateral ureter
KBH20	Replantation of ureter
KBH30	Ileal replacement of ureter
KBH40	Plastic repair of ureter
KBH50	Ureterolysis
KBH96	Other repair or connection of ureter
KBJ00	Cutaneous ureterostomy
KBJ10	Cutaneous ureteroenterostomy
KBJ20	Cutaneous ureteroenterostomy with reservoir
KBJ40	Ureteroenterostomy
KBJ60	Anastomosis of ureter to urethra with interposition of ileum
KBJ70	Removal of calculus from ileal conduit or reservoir
KBJ80	Operation for malfunction of urinary diversion
KBJ96	Other urinary diversion from ureter or related operation
KBV00	Insertion of stent into ureter
KBV10	Removal of stent from ureter
KBV40	Incision or excision of ureterocele
KBW96	Other operation on ureter
KCA00	Exploratory cystotomy
KCB00	Biopsy of bladder
KCC00	Cystectomy
KCC10	Cystoprostatectomy
KCC20	Cystoprostatourethrectomy
KCC30	Cystectomy with excision of female internal genital organs
KCC96	Other cystectomy
KCD10	Partial cystectomy
KCD20	Excision of diverticulum of bladder
KCD30	Destruction of tumour of bladder

Code	Title
KCD40	Excision of urachus or other vesicocutaneous fistula
KCD96	Other partial excision or destruction of tumour of bladder
KCE00	Cystolithotomy
KCF00	Cystotomy and removal of foreign body from bladder
KCH00	Suture of bladder
KCH10	Enterocystoplasty
KCH20	Reduction cystoplasty
KCH30	Closure of vesicointestinal fistula
KCH40	Incision or resection of bladder neck
KCH96	Other reconstructive operation on bladder
KCJ00	Cystostomy
KCJ10	Cutaneous cystoenterostomy
KCJ20	Continent cutaneous cystoenterostomy
KCJ96	Other cystostomy
KCV10	Denervation of bladder
KCV20	Freeing of bladder
KCW96	Other operations on bladder
KDC00	Urethrectomy
KDD00	Partial excision of urethra
KDD10	Excision of diverticulum of urethra
KDD30	Destruction of tumour of urethra
KDD40	Resection of external sphincter of urethra
KDD50	Excision of urethral valve
KDD80	Partial excision of urethra and repair using graft or flap
KDD96	Other partial excision of urethra
KDG00	Retropubic suspension of urethra
KDG20	Abdominal colposuspension
KDG30	Suprapubic sling urethrocystopexy
KDG40	Suprapubic urethrocystopexy
KDG43	Transobturatorial sling urethrocystopexy
KDG50	Transabdominal plastic repair of pelvic floor for urinary incontinence
KDG60	Implantation of adjustable expander around bladder neck
KDG70	Exploration of urethra
KDG96	Other operation on urethra or bladder neck for incontinence
KDH00	Suture of urethra
KDH10	Meatoplasty of urethra
KDH30	Closure of urethrocutaneous fistula
KDH50	Closure of urethrointestinal fistula
KDH70	Plastic repair of stricture of urethra
KDH96	Other reconstructive operation on urethra
KDJ00	Urethrostomy
KDK00	Implantation of artificial urinary sphincter around bladder neck
KDK10	Implantation of artificial urinary sphincter around bulbar urethra
KDK30	Revision of artificial urethral sphincter

Code	Title
KDK40	Removal of artificial urethral sphincter
KDW96	Other operation on urethra
KEA00	Exploration of prostate
KEA10	Prostatotomy
KEA20	Incision of seminal vesicle
KEB00	Biopsy of prostate
KED96	Other partial excision of prostate
KEE00	Prostatalithotomy
KEE10	Removal of foreign body from prostate
KEW96	Other operation on prostate or seminal vesicle

Table 18- NCSP-N codes for procedures on female genital organs: ovary, fallopian tube, uterus and uterine ligaments

Code	Title
LAA00	Puncture of ovarian cyst
LAB00	Ovariotomy
LAB10	Biopsy of ovary
LAB96	Other incision or biopsy of ovary
LAC00	Excision of ovarian cyst
LAC10	Fenestration of ovarian cyst
LAC20	Destruction of lesion of ovary
LAC30	Excision of paraovarian cyst
LAC96	Other excision or destruction of lesion of ovary
LAD00	Partial excision of ovary
LAE10	Unilateral oophorectomy
LAE20	Bilateral oophorectomy
LAF00	Unilateral salpingo-oophorectomy
LAF10	Bilateral salpingo-oophorectomy
LAF20	Unilateral transvaginal salpingo-oophorectomy
LAF30	Bilateral transvaginal salpingo-oophorectomy
LAG00	Freeing of adhesions of ovary
LAG10	Oophoropexy
LAG20	Detorsion of ovary
LAG96	Other reconstructive operation on ovary
LAW96	Other operation on ovary
LBB00	Biopsy of Fallopian tube
LBB96	Other biopsy of Fallopian tube
LBC10	Removal of products of conception from Fallopian tube
LBC20	Salpingotomy and removal of products of conception
LBC96	Other tube conserving operation for tubal pregnancy
LBD00	Partial excision of Fallopian tube
LBE00	Salpingectomy
LBF00	Perfusion of Fallopian tube

Code	Title
LBF03	Perfusion of Fallopian tube after reconstruction
LBF20	Transcervical catheter salpingoplasty
LBF30	Salpingolysis
LBF40	Fimbrioplasty
LBF50	Salpingostomy
LBF60	Partial excision and anastomosis of Fallopian tube
LBF70	Partial excision and reimplantation of Fallopian tube
LBF96	Other operation on Fallopian tube for infertility
LBW96	Other operation on Fallopian tube
LCA00	Biopsy of uterus or uterine ligaments
LCB00	Hysterotomy
LCB10	Myomectomy
LCB96	Other excision of lesion of uterus
LCC00	Partial excision of uterus
LCC10	Supravaginal hysterectomy
LCC20	Vaginal supravaginal hysterectomy
LCC96	Other partial excision of uterus
LCD00	Hysterectomy
LCD10	Vaginal hysterectomy
LCD30	Radical hysterectomy
LCD40	Radical vaginal hysterectomy
LCD96	Other hysterectomy
LCE00	Anterior exenteration of female pelvis
LCE10	Posterior exenteration of female pelvis
LCE20	Total exenteration of female pelvis
LCE96	Other exenteration of female pelvis
LCF00	Excision of lesion of parametrium
LCF10	Excision of female varicocele
LCF96	Other excision of lesion of parametrium
LCG10	Suture of uterus
LCG20	Hysteropexy
LCG30	Resection or transcision of sacrouterine ligaments
LCG40	Reconstruction of uterus
LCG96	Other reconstructive operation on uterus
LCW96	Other operation on uterus and uterine ligaments

Table 19. NCSP-N codes for procedures on the peripheral vessels of the abdomen

Code	Title
PCB20	Ligature of coeliac trunk and branches
PCB30	Ligature of superior mesenteric artery
PCB40	Ligature of renal artery
PCB99	Ligature of other visceral artery
PCC10	Suture of suprarenal or juxtarenal abdominal aorta
PCC20	Suture of coeliac trunk and branches
PCC30	Suture of superior mesenteric artery
PCC40	Suture of renal artery
PCC99	Suture of other visceral artery
PCE30	Thrombectomy or embolectomy of superior mesenteric artery
PCE40	Thrombectomy or embolectomy of renal artery
PCE99	Thrombectomy or embolectomy of other visceral artery
PCF20	Thrombendarterectomy of coeliac trunk and branches
PCF30	Thrombendarterectomy of superior mesenteric artery
PCF40	Thrombendarterectomy of renal artery
PCF99	Thrombendarterectomy of other visceral artery
PCG10	Operation for aneurysm of supracoeliac or juxtarenal abdominal aorta
PCG20	Operation for aneurysm of coeliac trunk and branches
PCG30	Operation for aneurysm of superior mesenteric artery
PCG40	Operation for aneurysm of renal artery
PCG99	Operation for aneurysm of other visceral artery
PCH10	Bypass from supracoeliac or juxtarenal abdominal aorta
PCH20	Bypass to/from coeliac trunk and branches
PCH30	Bypass from superior mesenteric artery
PCH40	Bypass from renal artery
PCH99	Bypass from other visceral artery
PCJ30	Transposition of superior mesenteric artery
PCJ40	Transposition of renal artery
PCJ99	Transposition of other visceral artery
PCK20	Reimplantation of coeliac trunk and branches
PCK30	Reimplantation of superior mesenteric artery
PCK40	Reimplantation of renal artery
PCK50	Reimplantation of inferior mesenteric artery
PCK99	Reimplantation of other visceral artery
PCN20	Plastic repair of coeliac trunk and branches
PCN30	Plastic repair of superior mesenteric artery
PCN40	Plastic repair of renal artery
PCN99	Plastic repair of other visceral artery
PCU70	Exploration of previous reconstruction of suprarenal abdominal aorta or visceral arteries
PCU74	Thrombectomy or embolectomy in bypass from suprarenal abdominal aorta and visceral arteries
PCU81	Closure of persisting arteriovenous fistula of bypass from suprarenal abdominal aorta and visceral arteries
PCU82	Plastic repair in bypass from suprarenal abdominal aorta and visceral arteries
PCU99	Other repair after previous reconstruction of suprarenal abdominal aorta and visceral arteries

Code	Title
PCW99	Other operation on suprarenal abdominal aorta and visceral arteries
PDA10	Exploration of infrarenal abdominal aorta
PDA30	Exploration of iliac artery
PDC10	Suture of infrarenal abdominal aorta
PDC30	Suture of iliac artery
PDE10	Thrombectomy or embolectomy of infrarenal abdominal aorta
PDE30	Thrombectomy or embolectomy of iliac artery
PDF10	Thrombendarterectomy of infrarenal abdominal aorta
PDF30	Thrombendarterectomy of iliac artery
PDG10	Operation on infrarenal abdominal aorta for aneurysm
PDG20	Bypass from aorta to iliac artery for aneurysm
PDG21	Bypass from aorta to bilateral iliac arteries for aneurysm
PDG22	Bypass from aorta to iliac and contralateral femoral artery for aneurysm
PDG23	Bypass from aorta to femoral artery for aneurysm
PDG24	Bypass from aorta to bilateral femoral arteries for aneurysm
PDG30	Operation on iliac artery for aneurysm
PDG35	Bypass from iliac to femoral artery for aneurysm
PDG99	Other operation for aneurysm of infrarenal abdominal aorta and iliac arteries
PDH10	Bypass from infrarenal abdominal aorta
PDH20	Bypass from aorta to iliac artery
PDH21	Bypass from aorta to bilateral iliac arteries
PDH22	Bypass from aorta to iliac and contralateral femoral artery
PDH23	Bypass from aorta to femoral artery
PDH24	Bypass from aorta to bilateral femoral arteries
PDH30	Bypass from iliac artery
PDH35	Bypass from iliac to femoral artery
PDH99	Other bypass from abdominal aorta or iliac artery
PDN10	Plastic repair of infrarenal abdominal aorta
PDN30	Plastic repair of iliac artery
PDU70	Exploration of previous reconstruction of infrarenal abdominal aorta or iliac arteries and distal connections
PDU74	Thrombectomy or embolectomy in bypass from infrarenal abdominal aorta or iliac artery
PDU81	Closure of persisting arteriovenous fistula of bypass from infrarenal abdominal aorta or iliac artery
PDU82	Plastic repair of bypass from infrarenal abdominal aorta or iliac artery
PDU99	Other repair after previous reconstruction of infrarenal abdominal aorta and iliac arteries and distal
PDW99	Other operation on infrarenal abdominal aorta and iliac arteries and distal connections
PHB23	Ligature of iliac vein
PHB30	Ligature of inferior vena cava
PHB31	Ligature of renal vein
PHB32	Ligature of portal vein
PHB33	Ligature of v. mesenterica superior
PHB34	Ligature of v. mesenterica inferior
PHB36	Ligature of v. spermatica
PHC23	Suture of iliac vein
PHC30	Suture of inferior vena cava

Code	Title
PHC31	Suture of renal vein
PHC32	Suture of portal vein
PHC33	Suture of v. mesenterica superior
PHC34	Suture of v. mesenterica inferior
PHD30	Resection of inferior vena cava
PHD32	Resection of portal vein
PHD33	Resection of v. mesenterica superior
PHD34	Resection of v. mesenterica inferior
PHD36	Resection of v. spermatica
PHE23	Thrombectomy of iliac vein
PHE30	Thrombectomy of inferior vena cava
PHE31	Thrombectomy of renal vein
PHH25	Bypass from iliac vein
PHH30	Bypass from inferior vena cava
PHN30	Plastic repair of inferior vena cava
PHN32	Plastic repair of portal vein
PHN33	Plastic repair of v. mesenterica superior
PHN34	Plastic repair of v. mesenterica inferior
PHW35	Portosystemic shunt or bypass

The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	Title	RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	Title and abstract Abstract l 21 Title and abstract l 20-21 No linkages between databases
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported	Introduction, l 49-73		
Objectives	3	State specific objectives, including any prespecified hypotheses	Introduction, l 74-79		
Methods					
Study Design	4	Present key elements of study design early in the paper	Abstract, l 20-30.		
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Materials and methods		
Participants	6	*(a) Cohort study* - Give the eligibility criteria, and the	Materials and methods, l. 81-82	RECORD 6.1: The methods of study population selection (such as codes or	Materials and methods, l 96-109.

		sources and methods of selection of participants. Describe methods of follow-up *Case-control study* - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants *(b) Cohort study* - For matched studies, give matching criteria and number of exposed and unexposed *Case-control study* - For matched studies, give matching criteria and the number of controls per case	and l 96-109	algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	All codes are listed in the Supplementary File References to validation studies are given in Introduction, l 66-69, and in Discussion, l 196 Not considered relevant
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	Materials and methods, l 96-109, and Supplementary File. Model variables are specified in Statistical methods, l. 115-120	RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	Codes are listed in the Supplementary File
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Covered by the above		
Bias	9	Describe any efforts to address potential sources of bias	Hospital PWD rates are risk adjusted, see		

			statistical methods l 115-120		
Study size	10	Explain how the study size was arrived at	Determined by study period		
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	Model variables are specified in Statistical methods, l. 115-120		
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses	a) See Statistical methods c) No missing data were found in final data set d) Loss to follow up assumed to be very low and uniform across hospitals e) Materials and methods, l 131-134, Results, l 173-174		
Data access and cleaning methods		..		RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population. RECORD 12.2: Authors should provide information on the data cleaning	The authors had no accesss to the NPR's databases Materials and methods, l 89-91

				methods used in the study.	
Linkage		..		RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	NPR provided linkage to National Registry using the unique PIN
Results					
Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed) (b) Give reasons for non-participation at each stage. (c) Consider use of a flow diagram	Results, l 146-151	RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	
Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders (b) Indicate the number of participants with missing data for each variable of interest (c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)	a) Results, Table 1 b) See above c) Not relevant		
Outcome data	15	*Cohort study* - Report numbers of outcome events or summary measures over time *Case-control study* - Report numbers in each exposure category, or summary measures of exposure *Cross-sectional study* - Report	Results, Table 1		

		numbers of outcome events or summary measures			
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Results, l 156-157 and Figure 1, Table 2		
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	Results, l 168-174, Figure 1		
Discussion					
Key results	18	Summarise key results with reference to study objectives	Discussion, l 176-184		
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias		RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	Discussion, l 198-218
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Conclusions, l 220-231		

Generalisability	21	Discuss the generalisability (external validity) of the study results	Discussion, l 214-218		
Other Information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	No specific funding was received		
Accessibility of protocol, raw data, and programming code		..		RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	Contact the corresponding author

*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.

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POSTOPERATIVE WOUND DEHISCENCE AFTER LAPAROTOMY: A USEFUL HEALTH CARE QUALITY INDICATOR? A COHORT STUDY BASED ON NORWEGIAN HOSPITAL ADMINISTRATIVE DATA

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POSTOPERATIVE WOUND DEHISCENCE AFTER LAPAROTOMY: A USEFUL HEALTH CARE QUALITY INDICATOR? A COHORT STUDY BASED ON NORWEGIAN HOSPITAL ADMINISTRATIVE DATA

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ABSTRACT

Objectives

Postoperative wound dehiscence (PWD) is a serious complication to laparotomy, leading to higher mortality, readmissions and cost. The aims of the present study are to investigate whether risk adjusted PWD rates could reliably differentiate between Norwegian hospitals, and whether PWD rates were associated with hospital characteristics such as hospital type and laparotomy volume.

Design

Observational study using patient administrative data from all Norwegian hospitals, obtained from the Norwegian Patient Registry, for the period 2011-2015, and linked using the unique person identification number.

Participants

All patients undergoing laparotomy, at least 15 years old, with length of stay at least two days, and no diagnosis code for immunocompromised state or relating to pregnancy, childbirth and puerperium. The final data set comprised 66 925 patients with 78 086 laparotomy episodes from 47 hospitals.

Outcomes

The outcome was wound dehiscence, identified by the presence of a wound reclosure code, risk adjusted for patient characteristics and operation type.

Results

The final data set comprised 1 477 wound dehiscences. Crude PWD rates varied from 0% to 5.1% among hospitals, with an overall rate of 1.89%. Three hospitals with statistically significantly higher PWD than average were identified, after case mix adjustment and correction for multiple comparisons. Hospital volume was not associated with PWD rate, except that hospitals with very few laparotomies had lower PWD rates.

Conclusions

Among Norwegian hospitals, there is considerable variation in PWD rate that cannot be explained by operation type, age or comorbidity. This warrants further investigation into possible causes, such as surgical technique, perioperative procedures or handling of complications. The risk adjusted PWD rate after laparotomy is a candidate quality indicator for Norwegian hospitals.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- Includes all laparotomies performed in the nation over a five-year period, with patients followed across hospitals
- Extends previous studies to a new health system and a new coding system
- The statistical analysis uses methods for low event rates, avoiding asymptotic approximation
- Results may be subject to coding inaccuracy and incompleteness, as well as selection effects
- There were no data for surgical technique, nor for some clinical factors known to be relevant.

INTRODUCTION

The past decades have seen a major growth in initiatives for measuring, monitoring, and improving the quality of health care services. Quality indicators are regularly published in many health care systems. Performance of health care systems is also compared across nations, for instance in the OECD Health Care Quality and Outcomes (HCQO) initiative, which Norway is a part of.[1 2] Norway has a national quality indicator system for monitoring and comparing hospital performance, however, not all areas of hospital performance are covered by existing national quality indicators. While there are quality indicators for outcomes such as mortality and process measures such as waiting times, complications following hospital care is less explored, which is especially relevant following surgical procedures.

Postoperative wound dehiscence (PWD) rates after open abdominal surgery (laparotomies) was introduced as a patient safety indicator in the United States and later as a quality indicator by OECD.[3-6] Norway reported the second highest numbers for 2014-2015, with a PWD rate of 1.02%. The overall range was 0.055% to 1.05%.[5] Neighbouring Sweden, with comparable population health and health care, reported 0.30%. Moreover, a recent study comparing adverse events in Norway and Sweden found significantly higher adverse event rates of surgical complications in Norwegian hospitals, compared to Swedish hospitals.[7]

PWD is a serious complication that leads to higher mortality rates, higher implicit, explicit and social costs as well as increased readmission rates.[8 9] The PWD rate has been studied elsewhere as a quality indicator for hospitals, and found to have a high positive predictive value.[10 11] It is useful as a quality indicator, since several of the risk factors are modifiable and within control of the hospital and surgical team. There are few events per hospital, making it challenging to identify outlier hospitals for quality improvement because of the high statistical uncertainty.

Previous research has identified a number of risk factors for PWD. Examples of such factors are: (I) patient related variables and comorbidities: smoking[12], obesity[13], chronic pulmonary disease, renal insufficiency or diabetes[14] and use of immunosuppressive agents[15 16]; (II) procedure related factors: operation type[9 17], type of incision and closure[18-20] and length of operation time[21]; (III) postoperative parameters: clean wound classification[21], coughing[9] and wound infection[9 14]; (IV) operative scenario: e.g. qualifications of the surgeon[21-23] and of the perioperative team, and whether the surgery is emergent.[9 13]

The objectives of this study are to study the occurrence and variation of PWD after laparotomy at Norwegian hospitals, and the potential usefulness of a PWD indicator for the Norwegian health care system, computed from patient administrative data. More specifically we aimed to 1) investigate the possibility to identify hospitals with higher or lower laparotomy PWD rate than average, after appropriate risk adjustment, 2) study the variability of the PWD rate among hospitals, and its relation to hospital type and laparotomy volume.

MATERIAL AND METHODS

Patient administrative data from all Norwegian hospitals were provided by the Norwegian Patient Registry (NPR) for the period 2011-2015.[24] This comprised individual patient data from all department stays: type of admission (acute or elective), primary and secondary diagnosis codes according to the Norwegian version[25] of ICD-10, surgical and medical procedures, age, gender, date and time of ward admission and discharge. Surgical procedures and operations were coded according to the Norwegian version of the NOMESCO Classification of Surgical Procedures (NCSP-N).[26] Procedure time and date were not available. It was therefore not possible to exclude reclosures of wounds occurring before or on the same day as laparotomies within the same episode, as requested in the OECD indicator specification. The NPR data files were checked for missing values and inconsistencies between variables, such as date and time of discharge before admission or invalid

ICD-10 code. We had no access to clinical data, such as e.g. type of suture, which would have enabled us to study the causes of the reported dehiscences.

Wound dehiscence was defined as the occurrence of a code for a reclosure operation, i.e. a reoperation for wound dehiscence. This excludes superficial dehiscences, as these are usually not resutured, and the code for reclosure operation is restricted to deep wound dehiscences. Laparotomies and wound reclosure operations were identified according to procedure codes. An operation coded with a laparotomy code, signifies an incision into the abdominal wall, through the fascia and with an opening of the abdominal cavity. Laparoscopic and endoscopic procedures were not included. Details of the codes used can be found in the online supplement.

All permanent residents in Norway have a Personal Identification Number (PIN), registered in the NPR. NPR prepared an encrypted PIN for all patients with a valid PIN, allowing tracking of patients over time and between hospitals. The data were linked with the National Registry to provide data of death (when applicable), using the PIN.

Ward admissions for each patient, at more than one hospital in case of transfers, were linked into episodes of care when less than eight hours elapsed from time of discharge to the next ward admission.[27] An episode was regarded as acute if the first admission in the episode was coded as non-elective, as a laparotomy episode if it included any procedure code for laparotomy (reclosures not included), and a reclosure episode if a reclosure code was found. The initial data set consisted of all laparotomy and reclosure episodes. Each reclosure episode was linked to the laparotomy episode immediately preceding or coinciding with it. Reclosure episodes with no preceding laparotomy episode within 30 days, as well as laparotomy or reclosure episodes following a reclosure episode within 30 days, were excluded. Note that the linking of laparotomies and reclosures was not part of the original OECD specification, but is required in order to attribute PWD to hospitals and to enable risk adjustment. Following the OECD specification, laparotomy episodes (and consequently any

linked reclosure episodes) were excluded if a diagnosis code for immunocompromised state or relating to pregnancy, childbirth and puerperium was present, if the length of stay was less than two days, or if the patient's age was less than 15 years. Hospitals with less than 10 laparotomies over the five-year period were excluded. The hospitals belonged to one of three types: regional, large with acute function and small with acute function. For details of the diagnosis and operation codes used, see the online supplement. For risk adjustment, Charlson comorbidities were determined from previous admissions three years prior to, but not including the current episode of care.[27-29] Diagnoses were grouped according to the Clinical Condition Summary system (CCS), adapted to the Norwegian version of ICD-10.[30]

Statistical methods

Risk adjusted probabilities for a laparotomy episode resulting in a reclosure operation were estimated by bias corrected logistic regression.[31] The final model was fit by stepwise regression with the BIC criterion, allowing for potential two-way interactions.

To identify outlier hospitals, i.e. those with high or low risk adjusted PWD probabilities, estimated hospital effects were compared to a reference value, defined as the 25% trimmed mean of the hospital effects on the logistic scale.[32] As some hospitals reported zero reclosures, ordinary maximum likelihood estimates of the model parameters do not exist, due to separation[33], and the estimated variances of the fitted parameters, based on their asymptotic distribution, become unreliable. The comparison used an exact test based on the Poisson binomial distribution for the number of PWDs per hospital, using the estimated probabilities for each case, together with parametric bootstrapping to account for the estimation uncertainty in the model parameters. Tests for significance were corrected for multiple comparisons using the Guo-Romano method[34], and outlier status assigned according to the false discovery rate (FDR). An FDR not exceeding 5% was regarded as significant. For sensitivity analysis, two alternative risk adjustment models were tested, with either a four-category

grouping of procedures, or with diagnosis categories, instead of the 13-category procedure grouping. In addition, a model with the four Norwegian hospital regions was also estimated.

Hospital volume, modelled by splines[35], was tested for inclusion in the model. We also performed this test after exclusion of hospitals with zero reclosures.

Finally, the hospital specific effects were modelled as a mixture of two normal distributions. The expectation-maximization (EM) algorithm was used, taking into account the estimation variances. The mixture model yielded estimates of the quartiles of the hospital odds ratios and the scaled interquartile range (normalized by dividing by 1.349, to give the standard deviation in the case of a normal distribution) was computed as a measure of spread among hospitals. Bootstrapping of the mixture model was used to find a 95% confidence interval for the scaled interquartile range.

Risk adjustment

The following case-mix variables were included as candidates in the stepwise regression: age, gender, indicators for the individual Charlson comorbidities, number of previous hospital admissions two years prior to current admission, and whether the episode was acute or elective. A linear trend in admission year was also included. Age was modelled by natural splines with knots at the median and quartiles.[35] Based on previous studies of risk factors[9 17], procedures were categorized into 13 types, according to the body system or organ involved. The effects of operation types were normalized to have zero sum on the logistic scale.

For a quality indicator, only characteristics of the patient when entering the hospital, are meaningful risk adjustment variables. No data were available for smoking, obesity or other patient or case characteristics such as nutritional status. There was no information about operation urgency beyond the status of the hospital admission or episode as elective or acute.

Patient and Public Involvement

Patients were not involved in the planning, conduct or analysis of this study. The policy of the Norwegian Institute of Public health is to publish hospital quality indicators, when they have been successfully validated.

RESULTS

The initial data set comprised 96 102 episodes with laparotomy and 1 909 with a reclosure operation. After restricting data to reclosures paired with a laparotomy within 30 days, 1 580 reclosures remained. After exclusions for pregnancy, childbirth and puerperium or immunocompromised state, age and LOS, 78 299 laparotomies remained. Lastly, hospitals with less than 10 laparotomies were excluded, yielding a final data set with 66 925 unique patients, 78 086 laparotomies and 1 477 reclosures from 47 hospitals. Descriptive statistics for the dataset are shown in Table 1. The operation types are tabulated in the online Supplement.

Table 1. Descriptive statistics for final data set

	PWD	**No PWD**
Age, years, median (quartiles)	69 (61-78)	65 (51-75)
Gender, females, n (%)	517 (35)	43 094 (56)
Acute laparotomy episode, n (%)	657 (44)	26 381 (34)
Main diagnosis for reclosure episode coded as PWD, n (%)	45 (3.1)	—
Main diagnosis for reclosure episode coded as deep wound infection, n (%)	274 (19)	—
Hospital type for laparotomy episodes		
Regional, n (%)	545 (37)	28 104 (37)
Large with acute function, n (%)	810 (55)	40 291 (53)
Small with acute function, n (%)	122 (8.3)	8 214 (11)
Comorbidities		
Diabetes with complications, n (%)	18 (1.2)	893 (1.2)
Chronic pulmonary disease, n (%)	196 (13)	5 147 (6.7)
Renal disease, n (%)	66 (4.5)	2 716 (3.5)

30 day mortality (laparotomy episode), %	67 (4.5)	2 668 (3.5)
Length of stay (LOS) laparotomy episode, days, median (quartiles)	19 (11-29)	7.4 (4.4-13)
Reclosure and matched laparotomy in same episode, n (%)	1 211 (82)	—
Converted from laparoscopy or endoscopy to laparotomy, n (%)	12 (0.81)	578 (0.75)
Robot assistance in laparotomy, n (%)	3 (0.2)	404 (0.53)

From 2011 to 2015, the annual volume of laparotomies decreased somewhat, from 16 730 to 14 419, while the proportion of acute laparotomies remained stable at around 35%.

The overall rate of PWD for the five-year period was 1.89%. Crude PWD rates varied from 0% to 5.1% among hospitals. After risk adjustment, the range was 0.1% - 5.4%. Table 2 shows the odds ratios of the final logistic regression model. No interactions were included. The model showed good fit according to the modified Hosmer-Lemeshow test[36] (p=0.53) and good predictive ability, with an area under the operating characteristic (c-statistic) of 0.73.

Table 2. Final multivariate logistic model for risk adjustment

Variable	**Adjusted odds ratio**	**(95% confidence interval)**
Year of admission	0.93	(0.90-0.96)
Age, spline function		
40 (reference)	1.00	
50	1.37	(1.25-1.49)
60	1.97	(1.65-2.36)
70	2.39	(1.97-2.90)
Gender		
Female (reference)	1	
Male	2.42	(2.16-2.72)
Elective laparotomy episode (reference)	1	
Acute laparotomy episode	1.36	(1.21-1.52)
Chronic pulmonary disease	1.72	(1.47-2.01)
Operation type[a]		
Exploratory laparotomy	2.40	(1.78-3.24)
Hernia (diaphragmal)	2.57	(1.37-4.81)
Thoracoabdominal aorta	2.08	(0.85-5.09)
Gastrointestinal tract	2.04	(1.69-2.46)
Liver	1.14	(0.69-1.87)

Biliary tract	0.12	(0.05-0.28)
Pancreas	0.79	(0.40-1.58)
Spleen	1.20	(0.45-3.24)
Other digestive system	1.46	(1.03-2.07)
Kidney	0.09	(0.03-0.28)
Other urinary and male genital organs	0.52	(0.37-0.71)
Female genital organs	1.43	(1.06-1.92)
Peripheral vascular surgery	1.21	(0.93-1.57)
More than one type of surgery[b]	2.58	(2.12-3.15)
Hospital		
Scaled interquartile range	0.30	(0.23-0.34)

[a] Odds ratios for operation type is scaled to have geometric mean

[b] Not counting exploratory laparotomy

In Figure 1, risk-adjusted PWD rates are shown for each hospital, plotted versus laparotomy volume and hospital type.

After significance testing, we identified three hospitals with higher PWD and none with lower PWD than average, when correcting for multiple testing. Without multiple test correction, one additional hospital with high PWD was found to be marginally significant (p=0.053).

In the alternative model including volume, the PWD increased with yearly laparotomy volume from a very low level up to 120 laparotomies per year, after which it remained fairly constant, see Figure 1. The effect of volume was significant (p<0.001), also after exclusion of the four smallest volume hospitals with zero reclosures (p=0.008). Hospital type coincided almost completely with a grouping of hospitals by volume, and was therefore not tested separately. There was significant variation among regions (p<0.001), with the Northern region having the highest and the South-Eastern region the lowest rates. Details can be found in the online supplement. Using diagnosis categories or aggregated operation type as risk adjustment variables resulted in very small changes in risk adjusted PWD rates.

DISCUSSION

We have studied wound dehiscence after laparotomy, as a quality indicator based on the OECD specification, and found that it discriminated between Norwegian hospitals. The indicator was risk adjusted for differences in age, gender, comorbidity and type of surgery, and showed little sensitivity to changes in the set of risk adjustment variables. The overall PWD rate was 1.89%. After risk adjustment, the hospitals' PWD rate varied between 0.1% and 5.4%. Laparotomy volume and type of hospital had little effect on the PWD rate, except for hospitals with very low volume. Advanced age, male gender, chronic pulmonary disease, and emergency laparotomy were all significant risk factors for PWD. There were significant PWD differences according to the organ system targeted. The overall rate of PWD showed a small but statistically significant decline over the observation period 2011-2015. The relatively large variation of PWD rates between hospitals, after correction for patient characteristics and operation type, indicates possible variation in the quality of healthcare among hospitals. This may be due to variation in surgical technique and perioperative care, as well as the handling of postoperative complications, such as wound infection, which is known to be a risk factor for PWD.[17] We found PWD rates well within the range reported in international studies.[9 13 14 17 21 37 38] Also, the risk factors identified are in accordance with previous studies, albeit limited to administrative data. Laparotomy volume has negligible effect apart from the few hospitals with very low volume. A Japanese study reported a similar conclusion, while volume was found to have effect in US hospitals.[39 40] The effect is likely a result of the types of operations performed at the low-volume hospitals, compared with the other hospitals.

Our study is based on complete data from all Norwegian hospitals performing laparotomies. It was possible to track patients during transfers and reoperations at different hospitals. To the best of our knowledge, no similar study has been performed. NPR, the data source, has been validated for several disease categories with respect to identification of cases based on diagnoses and/or

procedures, and found to have a very high degree of completeness, compared to Norwegian national medical quality registries.[41-44] At the time of writing, the completeness of NPR, after 24 registries have been studied, ranges from 83.5% to 99.8%.[24]

We cannot exclude a residual imbalance in case mix, affecting PWD through e.g. smoking or obesity, which are known risk factors. There is regional variation in the prevalence of smoking and obesity in Norway.[45] Obesity is more prevalent in Northern Norway, where PWD rates are somewhat higher. However, in some other areas where obesity is less prevalent, the rates are similar. There is no consistent correspondence between the known variation in smoking among counties and PWD rates. Some surgical procedures are performed only at regional hospitals, and it is therefore possible that selection effects are present. In that case, one would expect larger changes in PWD rates after risk adjustment for operation type, which was not found. One potential source of error in our study is the completeness and correctness of coding in the NPR, particularly the coding of reclosure operations. The risk adjustment depends on data from previous hospitalization and may not capture all comorbidities. Moreover, selection effects cannot not be ruled out. Differing policies for operations on patients with known risk factors, e.g. obesity or smoking, would likely cause variation in PWD rates. Patients who die before reoperation or are managed by other means will not be registered. We believe that this applies to very few patients and would not influence our results. No attempt was made to identify main operation or operation intent, as this would require a classification effort outside the scope of the present study. No clinical details about surgical technique and patient condition were available. Therefore, the causes of the observed PWD rate variation could not be investigated.

Previous studies have shown that the quality indicator has high positive predictive value, but only moderate sensitivity.[10 46 47]Since we have used specific wound reclosure codes, similar to those used in previous studies, we expect a high positive predictive value in Norway as well. Conceivably, the sensitivity depends on the coding system, in particular the various alternative codes related to

complications. Sensitivity in Norway may thus differ from that of other healthcare systems. A recent retrospective medical record study from neighbouring Sweden reports that 86.9% of wound dehiscences were reoperated.[38] Norway has an activity-based system for financing hospitals, which is an incentive to report all reclosure operations.

Conclusions

Among Norwegian hospitals, there is a significant variation in PWD rate after laparotomies that cannot be explained by operation type, age, comorbidity or whether the admission was elective or acute. This warrants further investigation into possible causes, such as patient related factors, surgical technique, perioperative procedures or handling of complications, e.g. wound infections. Some of these factors are known to be amenable.[20 48] The relatively large between-hospital variation found in the present study is an indication of potential for improvement. The risk adjusted PWD rate after laparotomy is a candidate for use as a quality indicator for Norwegian hospitals, and will make it possible to identify hospitals with apparent quality problems. To achieve sufficient discrimination, however, five-year data are desirable, making it more difficult to monitor changes in hospital performance resulting from quality improvement efforts. It lies outside the scope of the present study to perform a comprehensive validation of the PWD rate as a quality indicator suitable for public reporting. There are uncertainties and potential biases in the indicator, implying that it must be regarded as a signal for follow-up within hospitals, rather than giving a final verdict of inferior or superior quality. For reporting on surgical quality, several indicators should be used to give a balanced view of the different aspects of quality and patient safety.

FOOTNOTES

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Competing interests

The authors have no competing interests.

Authors' contributions

AKL and OT conceived the study. DTK, TMH, OT, and SH participated in data preparation. OT, SH and AKL contributed to the analysis. OT helped draft the manuscript. JH was responsible for the statistical analysis and final manuscript. All authors revised and approved the final manuscript.

Ethics approval

The study was approved by the Norwegian Directorate of Health and the Norwegian Data Protection Authority.

Data sharing

The data set contains indirectly identifiable personal data, and cannot be shared without express permission from the Norwegian Patient Registry. For further information, contact the corresponding author.

Figure 1. Risk adjusted PWD rates versus yearly laparotomy volume, by hospital type. Trend curve is obtained by smoothing the scatterplot. Significance testing is adjusted for multiple comparisons

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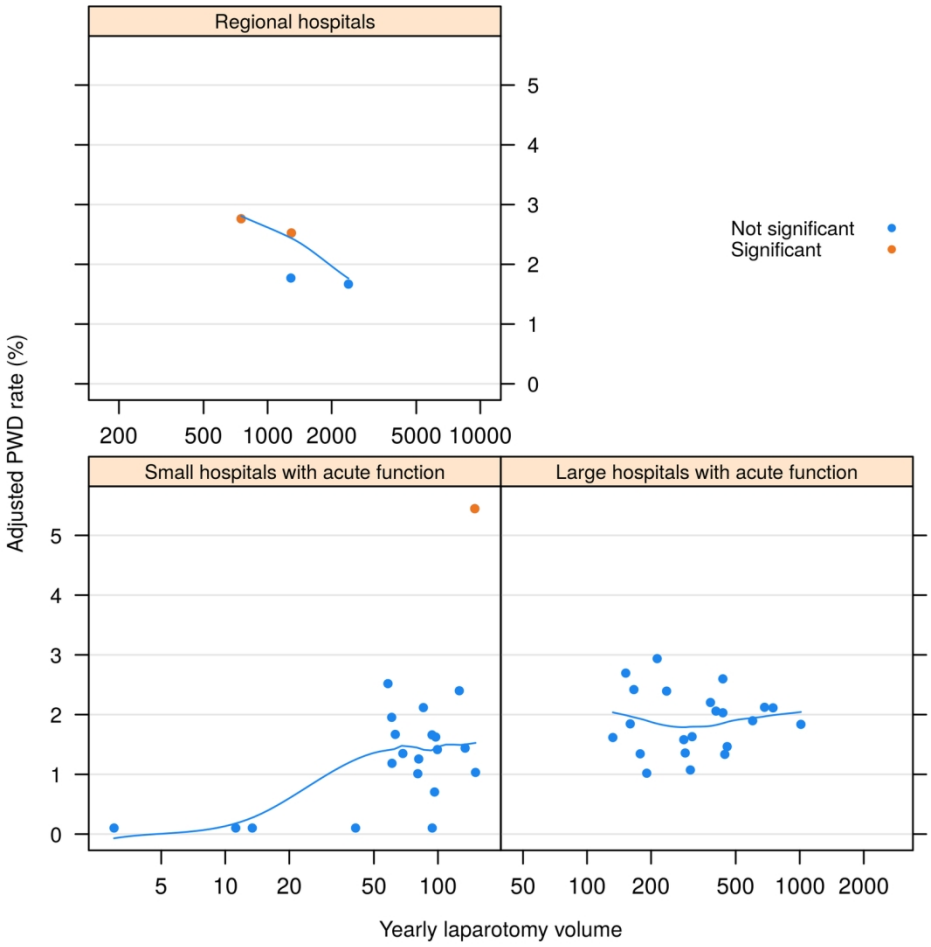

Figure 1. Risk adjusted PWD rates versus yearly laparotomy volume, by hospital type. Trend curve is obtained by smoothing the scatterplot. Significance testing is adjusted for multiple comparisons

149x149mm (300 x 300 DPI)

Online supplement

Table 1. Hospital types

Hospital type	Number
Small hospitals with acute function	21
Large hospitals with acute function	22
Regional hospitals	4

Table 2. Laparotomy cases after operation type (primary episode)

Operation type	Frequency, n (%)
Gastrointestinal tract	30 404 (38.9)
More than one type of surgery[a]	14 051 (18.0)
Female genital organs	10 720 (13.7)
Other urinary and male genital organs	6 536 (8.4)
Peripheral vascular surgery	4 628 (5.9)
Biliary tract	2 739 (3.5)
Other digestive system	2 226 (2.9)
Kidney	2 152 (2.8)
Exploratory laparotomy	2 061 (2.6)
Liver	1 122 (1.4)
Pancreas	775 (1.0)
Hernia (diaphragmal)	274 (0.4)
Spleen	248 (0.3)
Thoracoabdominal aorta	150 (0.2)

[a]Not counting exploratory laparotomy

Table 3. Effect of hospital region, after risk adjustment. Odds ratio standardized to have geometric mean one.

Hospital region	Adjusted odds ratio (95% confidence interval)
South-Eastern Norway Region	0.85 (0.78 - 0.92)
Central Norway Region	0.99 (0.89 - 1.10)
Western Norway Region	1.06 (0.96 - 1.17)
Northern Norway Region	1.13 (1.001 - 1.27)

Diagnoses

Table 4. ICD-10 diagnosis codes contained in MDC 14 (Pregnancy, childbirth, and puerperium)

Code	Title
A34	Obstetrical tetanus
F53.0	Mild mental and behavioural disorders associated with the puerperium, not elsewhere classified
F53.1	Severe mental and behavioural disorders associated with the puerperium, not elsewhere classified
F53.8	Other mental and behavioural disorders associated with the puerperium, not elsewhere classified
F53.9	Puerperal mental disorder, unspecified
Oxx.x	Pregnancy, childbirth and puerperium
Z32.0	Pregnancy, not (yet) confirmed
Z32.1	Pregnancy confirmed
Z33	Pregnant state, incidental
Z34.0	Supervision of normal first pregnancy
Z34.8	Supervision of other normal pregnancy
Z34.9	Supervision of normal pregnancy, unspecified
Z35.0	Supervision of pregnancy with history of infertility
Z35.1	Supervision of pregnancy with history of abortive outcome
Z35.2	Supervision of pregnancy with other poor reproductive or obstetric history
Z35.3	Supervision of pregnancy with history of insufficient antenatal care
Z35.4	Supervision of pregnancy with grand multiparity
Z35.5	Supervision of elderly primigravida
Z35.6	Supervision of very young primigravida
Z35.8	Supervision of other high-risk pregnancies
Z35.9	Supervision of high-risk pregnancy, unspecified
Z36.0	Antenatal screening for chromosomal anomalies
Z36.1	Antenatal screening for raised alphafetoprotein level
Z36.2	Other antenatal screening based on amniocentesis
Z36.3	Antenatal screening for malformations using ultrasound and other physical methods
Z36.4	Antenatal screening for fetal growth retardation using ultrasound and other physical methods
Z36.5	Antenatal screening for isoimmunization
Z36.8	Other antenatal screening
Z36.9	Antenatal screening, unspecified
Z37.0	Single live birth
Z37.1	Single stillbirth
Z37.2	Twins, both liveborn
Z37.3	Twins, one liveborn and one stillborn
Z37.4	Twins, both stillborn
Z37.5	Other multiple births, all liveborn
Z37.6	Other multiple births, some liveborn
Z37.7	Other multiple births, all stillborn
Z37.9	Outcome of delivery, unspecified
Z39.0	Care and examination immediately after delivery
Z39.1	Care and examination of lactating mother
Z39.2	Routine postpartum follow-up
Z64.0	Problems related to unwanted pregnancy

Table 5. ICD-10 diagnosis codes for immunocompromised state

Code	Title
B20.0	HIV disease resulting in mycobacterial infection
B20.1	HIV disease resulting in other bacterial infections
B20.2	HIV disease resulting in cytomegaloviral disease
B20.3	HIV disease resulting in other viral infections
B20.4	HIV disease resulting in candidiasis
B20.5	HIV disease resulting in other mycoses
B20.6	HIV disease resulting in Pneumocystis carinii pneumonia
B20.7	HIV disease resulting in multiple infections
B20.8	HIV disease resulting in other infectious and parasitic diseases
B20.9	HIV disease resulting in unspecified infectious or parasitic disease
B21.0	HIV disease resulting in Kaposi's sarcoma
B21.1	HIV disease resulting in Burkitt's lymphoma
B21.2	HIV disease resulting in other types of non-Hodgkin's lymphoma
B21.3	HIV disease resulting in other malignant neoplasms of lymphoid, haematopoietic and related tissue
B21.7	HIV disease resulting in multiple malignant neoplasms
B21.8	HIV disease resulting in other malignant neoplasms
B21.9	HIV disease resulting in unspecified malignant neoplasm
B22.0	HIV disease resulting in encephalopathy
B22.1	HIV disease resulting in lymphoid interstitial pneumonitis
B22.2	HIV disease resulting in wasting syndrome
B22.7	HIV disease resulting in multiple diseases classified elsewhere
B23.1	HIV disease resulting in (persistent) generalized lymphadenopathy
B23.2	HIV disease resulting in haematological and immunological abnormalities, not elsewhere classified
B23.8	HIV disease resulting in other specified conditions
B24	Unspecified human immunodeficiency virus [HIV] disease
B59	Pneumocystosis
D47.1	Chronic myeloproliferative disease
D70	Agranulocytosis
D71	Functional disorders of polymorphonuclear neutrophils
D72.0	Genetic anomalies of leukocytes
D80.0	Hereditary hypogammaglobulinaemia
D80.1	Nonfamilial hypogammaglobulinaemia
D80.2	Selective deficiency of immunoglobulin A [IgA]
D80.3	Selective deficiency of immunoglobulin G [IgG] subclasses
D80.4	Selective deficiency of immunoglobulin M [IgM]
D80.5	Immunodeficiency with increased immunoglobulin M [IgM]
D80.6	Antibody deficiency with near-normal immunoglobulins or with hyperimmunoglobulinaemia
D80.7	Transient hypogammaglobulinaemia of infancy
D80.8	Other immunodeficiencies with predominantly antibody defects
D80.9	Immunodeficiency with predominantly antibody defects, unspecified
D81.0	Severe combined immunodeficiency [SCID] with reticular dysgenesis
D81.1	Severe combined immunodeficiency [SCID] with low T- and B-cell numbers
D81.2	Severe combined immunodeficiency [SCID] with low or normal B-cell numbers
D81.3	Adenosine deaminase [ADA] deficiency
D81.4	Nezelof's syndrome
D81.5	Purine nucleoside phosphorylase [PNP] deficiency
D81.6	Major histocompatibility complex class I deficiency
D81.7	Major histocompatibility complex class II deficiency
D81.8	Other combined immunodeficiencies
D81.9	Combined immunodeficiency, unspecified
D82.0	Wiskott-Aldrich syndrome
D82.1	Di George's syndrome

Code	Title
D82.2	Immunodeficiency with short-limbed stature
D82.3	Immunodeficiency following hereditary defective response to Epstein-Barr virus
D82.4	Hyperimmunoglobulin E [IgE] syndrome
D82.8	Immunodeficiency associated with other specified major defects
D82.9	Immunodeficiency associated with major defect, unspecified
D83.0	Common variable immunodeficiency with predominant abnormalities of B-cell numbers and function
D83.1	Common variable immunodeficiency with predominant immunoregulatory T-cell disorders
D83.2	Common variable immunodeficiency with autoantibodies to B- or T-cells
D83.8	Other common variable immunodeficiencies
D83.9	Common variable immunodeficiency, unspecified
D84.0	Lymphocyte function antigen-1 [LFA-1] defect
D84.1	Defects in the complement system
D84.8	Other specified immunodeficiencies
D84.9	Immunodeficiency, unspecified
D89.8	Other specified disorders involving the immune mechanism, not elsewhere classified
D89.9	Disorder involving the immune mechanism, unspecified
E40	Kwashiorkor
E41	Nutritional marasmus
E42	Marasmic kwashiorkor
E43	Unspecified severe protein-energy malnutrition
I12.0	Hypertensive renal disease with renal failure
I13.1	Hypertensive heart and renal disease with renal failure
I13.2	Hypertensive heart and renal disease with both (congestive) heart failure and renal failure
K91.2	Postsurgical malabsorption, not elsewhere classified
N18.0	End-stage renal disease
N18.5	Chronic kidney disease, stage 5
N18.8	Other chronic renal failure
T86.0	Bone-marrow transplant rejection
T86.1	Kidney transplant failure and rejection
T86.2	Heart transplant failure and rejection
T86.3	Heart-lung transplant failure and rejection
T86.4	Liver transplant failure and rejection
T86.8	Failure and rejection of other transplanted organs and tissues
T86.9	Failure and rejection of unspecified transplanted organ and tissue
Y83.0	Surgical Operation with transplant of whole organ or tissue
Z49.0	Preparatory care for dialysis
Z49.1	Extracorporeal dialysis
Z49.2	Other dialysis
Z94.0	Kidney transplant status
Z94.1	Heart transplant status
Z94.2	Lung transplant status
Z94.3	Heart and lungs transplant status
Z94.4	Liver transplant status
Z94.8	Other transplanted organ and tissue status
Z94.9	Transplanted organ and tissue status, unspecified

Operations

Procedure codes for laparotomy and operation types. Laparotomy codes are the total of codes in tables 6-19. Note that a last code digit of 0, 3 or 6 signifies an open or other non-endoscopic operation or procedure, except for peripheral vascular surgery.

Table 6. NCSP-N codes for reclosure procedures

Code	Title
JWA00	Repair of wound dehiscence in gastroenterological surgery
KWA00	Repair of wound dehiscence in urological surgery
LWA00	Repair of wound dehiscence in gynaecological surgery
PWA00	Repair of wound dehiscence in surgery of peripheral vessels and lymphatic system

Table 7. NCSP-N code for exploratory laparotomy and opening of abdominal cavity

Code	Title
JAA00	Incision of abdominal wall
JAH00	Laparotomy
JAH20	Staging laparotomy
JAH30	Laparostomy
JAH33	Opening of laparostomy
JAH40	Thoracolaparotomy

Table 8. NCSP-N codes for diaphragmal hernia repair

Code	Title
JBB00	Repair of paraoesophageal hernia
JBB10	Repair of congenital diaphragmatic hernia
JBB96	Repair of other diaphragmatic hernia
JBC00	Gastro-oesophageal antireflux operation

Table 9. NCSP-N codes for repair of thoracoabdominal aorta

Code	Title
FCD00	Suture of thoracoabdominal aorta
FCD10	Reinforcement of thoracoabdominal aorta using suture
FCD30	Repair of thoracoabdominal aorta using patch
FCD40	Partial resection and suture of thoracoabdominal aorta
FCD50	Resection and reconstruction of thoracoabdominal aorta using tube graft
FCD60	Resection of thoracoabdominal aorta and reimplantation of branches
FCD70	Bypass of thoracoabdominal aorta using tube graft
FCD80	Removal of foreign body from thoracoabdominal aorta
FCD96	Other repair of thoracoabdominal aorta

Table 10. NCSP-N codes for procedures on the gastrointestinal tract: oesophagus, stomach and intestines

Code	Title
JCB00	Oesophagostomy
JCC00	Transhiatal partial oesophagectomy without interposition
JCC10	Transthoracic partial oesophagectomy without interposition
JCC20	Transhiatal partial oesophagectomy with interposition of intestine
JCC30	Transthoracic partial oesophagectomy with interposition of intestine
JCC96	Other partial oesophagectomy
JCD00	Subcutaneous anastomosis of oesophagus without interposition
JCD03	Subcutaneous anastomosis of oesophagus with interposition of intestine
JCD10	Intrathoracic anastomosis of oesophagus without interposition
JCD13	Intrathoracic oesophageal anastomosis with interposition of intestine
JCD20	Transsection of oesophagus
JCD96	Other anastomosis of oesophagus without resection
JCE00	Suture of oesophagus
JCE10	Plastic repair of stenosis of cardia
JCE20	Cardiomyotomy
JCE30	Repair of oesophageal atresia or congenital tracheo-oesophageal fistula
JCE33	Closure of acquired tracheo-oesophageal or broncho-oesophageal fistula
JCE40	Reconstruction of oesophagus using flap
JCE50	Reconstruction of oesophagus using free microvascular graft of intestine
JCE96	Other reconstruction of oesophagus
JCF00	Insertion of oesophageal stent
JCW96	Other operation on oesophagus
JDA00	Gastrotomy
JDA60	Closure of perforated ulcer of stomach
JDA63	Local excision of lesion of stomach
JDB00	Gastrostomy
JDB10	Percutaneous gastrostomy
JDC00	Partial gastrectomy and gastroduodenostomy
JDC10	Partial gastrectomy and gastrojejunostomy
JDC20	Partial gastrectomy and Roux-en-Y reconstruction
JDC30	Partial gastrectomy with interposition of jejunum
JDC40	Partial gastrectomy and oesophagogastrostomy
JDC96	Partial gastrectomy with other reconstruction
JDD00	Total gastrectomy and Roux-en-Y oesophagojejunostomy
JDD96	Total gastrectomy with other reconstruction
JDE00	Gastrojejunostomy
JDE10	Conversion of gastrojejunostomy to Roux-en-Y anastomosis
JDE20	Conversion of gastrojejunostomy to gastroduodenostomy with interposition of jejunum
JDE96	Other anastomosis of stomach without concurrent gastrectomy
JDF00	Gastroplasty

Code	Title
JDF10	Gastric bypass
JDF20	Gastric banding
JDF96	Other bariatric operation on stomach
JDG00	Truncal vagotomy
JDG10	Proximal gastric vagotomy
JDG96	Other vagotomy
JDH00	Duodenotomy
JDH40	Duodenostomy on duodenal bulb
JDH50	Local excision of lesion of duodenal bulb
JDH60	Pyloromyotomy
JDH63	Pyloroplasty
JDH70	Closure of perforated ulcer of duodenum
JDW96	Other operation on stomach or duodenum
JEA00	Appendectomy
JEA10	Appendectomy with drainage
JEW96	Other operation on appendix
JFA00	Enterotomy
JFA10	Colotomy
JFA16	Biopsy of wall of colon without colotomy
JFA60	Stricturoplasty in small intestine
JFA63	Stricturoplasty in colon
JFA70	Suture of small intestine
JFA73	Excision of lesion of small intestine
JFA76	Closure of fistula of small intestine
JFA80	Suture of colon
JFA83	Excision of lesion of colon
JFA86	Closure of fistula of colon
JFA96	Other local operation on intestine
JFB00	Partial resection of small intestine
JFB10	Reversal of segment of small intestine
JFB13	Plastic repair of small intestine with lengthening
JFB20	Ileocaecal resection
JFB30	Right hemicolectomy
JFB33	Other resection comprising small intestine and colon
JFB40	Resection of transverse colon
JFB43	Left hemicolectomy
JFB46	Resection of sigmoid colon
JFB50	Other resection of colon
JFB53	Resection of sigmoid colon sigmoideum with partial resection of rectum
JFB60	Resection of sigmoid colon with end colostomy
JFB63	Other resection of colon with proximal colostomy and closure of distal stump
JFB96	Other partial excision of intestine
JFC00	Entero-enterostomy
JFC10	Ileotransversostomy

Code	Title
JFC20	Other enterocolostomy
JFC30	Colo-colostomy
JFC40	Ileorectostomy
JFC50	Colorectostomy
JFD00	Jejunoileal bypass
JFD03	Duodenoileal bypass with biliopancreatic diversion
JFD10	Revision of jejunoileal bypass
JFD13	Revision of duodenoileal bypass
JFD20	Restoration of continuity after jejunoileal bypass
JFD23	Restoration of continuity after duodenoileal bypass
JFD96	Other intestinal bypass operation
JFE00	Transplantation of small intestine
JFE96	Other operation relating to transplantation of small intestine
JFF00	Catheter enterostomy
JFF10	Loop enterostomy
JFF13	Terminal enterostomy
JFF16	Conversion of ileoanal anastomosis to ileostomy
JFF20	Caecostomy
JFF23	Transversostomy
JFF26	Sigmoidostomy
JFF30	Other colostomy
JFF40	Appendicostomy
JFF50	Exteriorisation of loop of colon without opening
JFF60	Opening of exteriorised loop of colon
JFF96	Other exteriorisation of intestine or creation of intestinal stoma
JFG00	Closure of loop enterostomy without resection
JFG10	Closure of loop colostomy without resection
JFG20	Closure of enterostomy with resection of exteriorised loop
JFG23	Closure of terminal enterostomy with anastomosis to small intestine
JFG26	Closure of terminal enterostomy with anastomosis to colon
JFG30	Closure of colostomy with resection of exteriorised loop
JFG33	Closure of terminal colostomy with anastomosis to colon
JFG36	Closure of terminal colostomy with anastomosis to rectum
JFG40	Revision of enterostomy or colostomy without laparotomy
JFG50	Laparotomy with revision of enterostomy or colostomy
JFG53	Revision of ileal pelvic pouch
JFG56	Revision of colonic pelvic pouch
JFG60	Conversion of conventional ileostomy to continent ileostomy
JFG70	Conversion of continent ileostomy to conventional ileostomy
JFG73	Excision of ileal pelvic pouch
JFG76	Excision of colonic pelvic pouch with colorectal or coloanal anastomosis
JFG80	Excision of ileal pouch with construction of new continent ileostomy
JFG83	Excision of colonic pelvic pouch and construction of new pouch
JFG86	Excision of ileal pelvic pouch and construction of new pouch

Code	Title
JFG96	Other operation on intestinal stoma or pouch
JFH00	Total colectomy and ileorectal anastomosis
JFH10	Total colectomy and ileostomy
JFH20	Proctocolectomy and ileostomy
JFH30	Total colectomy, mucosal proctectomy and ileoanal anastomosis without ileostomy
JFH33	Total colectomy, mucosal proctectomy, ileoanal anastomosis and ileostomy
JFH40	Proctocolectomy and continent ileostomy
JFH96	Other total colectomy
JFJ00	Coecopexy
JFJ96	Other enteropexy or colopexy
JFK00	Division of adhesive band in intestinal obstruction
JFK10	Freeing of adhesions in intestinal obstruction
JFK20	Freeing of adhesions and plication of small intestine
JFK96	Other operation on adhesions in intestinal obstruction
JFL00	Open reduction of intussusception of intestine
JFL10	Laparotomy and manipulation of obstructed intestine
JFL20	Laparotomy and manipulation of impacted material
JFL96	Other operation for intestinal obstruction without resection or freeing of adhesions
JFW96	Other operation on intestine
JGA00	Proctotomy
JGA60	Suture of rectum
JGA70	Proctotomy and excision of lesion of rectum
JGA96	Other proctotomy or local operation on rectum
JGB00	Partial proctectomy and colorectal or coloanal anastomosis
JGB03	Partial proctectomy with partial excision of mesorectum
JGB06	Total mesorectal excision
JGB10	Partial proctectomy and end colostomy
JGB20	Partial rectosigmoidectomy and abdominoperineal pull-through anastomosis
JGB30	Abdominoperineal excision of rectum
JGB33	Abdominoperineal excision of rectum and intersphincter resection
JGB36	Wide excision of rectum
JGB40	Excision of rectum and end ileostomy
JGB50	Mucosal proctectomy and ileoanal anastomosis
JGB60	Excision of rectum and ileoanal anastomosis
JGB96	Other proctectomy or excision of rectum
JGC00	Rectopexy
JGC30	Excision and suture of rectal mucosa with imbrication of muscular layer
JGC96	Other reconstructive operation on rectum
JGW96	Other operation on rectum

Table 11. NCSP-N codes for procedures on the liver

Code	Title
JJA00	Exploration of liver
JJA10	Hepatotomy
JJA20	Open biopsy of liver
JJA23	Open needle biopsy of liver
JJA30	Fenestration of cyst of liver
JJA40	Excision of lesion of liver
JJA43	Destruction of lesion of liver
JJA50	Suture of liver
JJA96	Other local operation on liver
JJB00	Wedge resection of liver
JJB10	Atypical resection of liver
JJB20	Excision of single segment of liver
JJB30	Excision of two segments of liver
JJB40	Excision of segments II, III and IV of liver
JJB50	Excision of segments V, VI, VII and VIII of liver
JJB53	Excision of segments IV,V, VI, VII and VIII of liver
JJB60	Other excision of three or more segments of liver
JJB96	Other resection of liver
JJC00	Allogenic transplantation of liver
JJC10	Allogenic partial transplantation of liver
JJC20	Allogenic partial transplantation of liver from living donor
JJC30	Xenogenic transplantation of liver
JJC40	Xenogenic partial transplantation of liver
JJC50	Resection of transplanted liver
JJC60	Total excision of transplanted liver
JJC96	Other transplantation of liver or related operation
JJW96	Other operation on liver

Table 12. NCSP-N codes for procedures on biliary tract

Code	Title
JKA00	Cholecystotomy
JKA10	Cholecystostomy
JKA20	Cholecystectomy
JKA96	Other operation on gallbladder
JKB00	Incision of bile duct
JKB20	Intraoperative cholangioscopy
JKB30	Percutaneous transhepatic biliary drainage
JKB40	Suture of bile duct
JKB96	Other incision or related operation on bile duct
JKC00	Incision of bile duct and local excision of lesion
JKC10	Partial excision and anastomosis of bile duct

Code	Title
JKC20	Partial excision of bile duct and anastomosis to duodenum
JKC30	Partial excision of bile duct and anastomosis to jejunum
JKC40	Partial excision of right or left hepatic duct and anastomosis to jejunum
JKC50	Excision of papilla of Vater and anastomosis of bile duct to duodenum or jejunum
JKC96	Other excision of bile duct
JKD00	Anastomosis of gallbladder to jejunum
JKD10	Anastomosis of bile duct to duodenum
JKD20	Anastomosis of bile duct to jejunum
JKD30	Extrahepatic anastomosis of right or left hepatic duct to jejunum
JKD40	Anastomosis of intrahepatic bile duct to jejunum
JKD50	Hepatoportoenterostomy
JKD96	Other biliodigestive anastomosis without excision
JKE00	Transduodenal papillotomy
JKE06	Transduodenal sphincteroplasty
JKE96	Other transduodenal open operation on bile duct or ampulla of Vater
JKF00	Excision of cystic duct
JKF96	Other secondary operation on biliary tract
JKW96	Other operation on biliary tract

Table 13. NCSP-N codes for procedures on the pancreas

Code	Title
JLA00	Exploration of pancreas
JLA10	Biopsy of pancreas
JLB00	Incision of pancreas
JLB10	Pancreaticolithotomy
JLB96	Other incision, drainage or dilatation of pancreas
JLC00	Excision of lesion of pancreas
JLC10	Distal pancreatectomy
JLC20	Total pancreatectomy
JLC30	Pancreatoduodenectomy
JLC40	Total pancreatoduodenectomy
JLC50	Atypical pancreatectomy
JLC96	Other pancreatectomy
JLD00	Pancreaticojejunostomy
JLD10	Anastomosis of pancreatic pseudocyst to stomach
JLD20	Anastomosis of pancreatic pseudocyst to jejunum
JLE00	Allogenic total transplantation of pancreas with pancraticocystostomy
JLE03	Allogenic total transplantation of pancreas with pancreaticoenterostomy
JLE10	Allogenic segmental transplantation of pancreas
JLE16	Allogenic segmental transplantation of pancreas from living donor
JLE20	Allogenic islet cell transplantation
JLE30	Xenogenic islet cell transplantation

Code	Title
JLE40	Total excision of transplanted pancreas
JLE50	Occlusion of duct of transplanted pancreas
JLE56	Conversion of pancreaticocystostomy to pancreaticoenterostomy
JLE96	Other transplantation of pancreas or related operation
JLW96	Other operation on pancreas

Table 14. NCSP-N codes for procedures on the spleen

Code	Title
JMA00	Partial splenectomy
JMA10	Transabdominal total splenectomy
JMA20	Transthoracic total splenectomy
JMB00	Biopsy of spleen
JMB10	Repair of spleen
JMW96	Other operation on spleen

Table 15. NCSP-N codes for other digestive system procedures

Code	Title
JAA10	Excision of lesion of abdominal wall
JAA13	Wide excision of extensive necrotising conditions of abdominal wall
JAA96	Other local operation on abdominal wall
JAK00	Laparotomy and drainage of peritoneal cavity
JAK03	Laparotomy and peritoneal irrigation
JAK10	Laparotomy and insertion of peritoneal dialysis catheter
JAL00	Biopsy of peritoneum
JAL10	Laparotomy and removal of foreign body
JAL20	Excision or destruction of lesion of peritoneum
JAL23	Excision of local lesion of pelvic wall
JAL30	Omentectomy
JAL50	Intraabdominal revision of shunt of ventricle of brain
JAL96	Other excision of lesion of peritoneum
JAM00	Transposition of omentum
JAM10	Operation for malrotation of intestine
JAN00	Creation of peritoneovenous shunt
JAN10	Revision of peritoneovenous shunt
JAN20	Removal of peritoneovenous shunt
JAP00	Freeing of adhesions in the peritoneal cavity
JAQ00	Extensive excision of peritoneum
JAQ10	Intraoperative hypertermic chemotherapeutic perfusion of abdominal cavity
JAW96	Other operation on abdominal wall, peritoneum, mesentery or omentum
JBA00	Transabdominal repair of diaphragm for rupture

Code	Title
JBA10	Transabdominal biopsy or excision of lesion of diaphragm
JBA20	Transabdominal partial excision of diaphragm
JBW96	Other transabdominal operation on diaphragm or operation for gastro-oesophageal reflux

Table 16. NCSP-N codes for procedures on kidney and pelvis of kidney

Code	Title
KAA00	Exploration of kidney
KAA20	Exploratory nephrotomy
KAA30	Exploratory pyelotomy
KAA96	Other exploration of kidney or pelvis of kidney
KAB00	Biopsy of kidney or pelvis of kidney
KAC00	Nephrectomy
KAC20	Nephroureterectomy
KAD00	Partial nephrectomy
KAD10	Heminephrectomy
KAD40	Partial excision of pelvis of kidney
KAD50	Destruction of tumour of pelvis of kidney
KAD56	Destruction of lesion of renal parenchyma
KAD60	Percutaneous destruction of lesion of renal parenchyma
KAD96	Other partial excision of kidney or pelvis of kidney
KAE00	Nephrolithotomy
KAE10	Pyelolithotomy
KAE96	Other removal of calculus from kidney or pelvis of kidney
KAF00	Removal of foreign body from kidney
KAF10	Removal of foreign body from pelvis of kidney
KAH00	Suture of kidney
KAH10	Suture of pelvis of kidney
KAH30	Pyeloureteroplasty without division of ureteropelvic junction
KAH40	Pyeloureteroplasty with division of ureteropelvic junction
KAH50	Ureterocalyceal anastomosis
KAH70	Freeing of adhesions of ureteropelvic junction
KAH80	Nephropexy
KAH96	Other reconstruction of kidney or pelvis of kidney
KAS00	Autotransplantation of kidney
KAS10	Allogenic transplantation of kidney from cadaver donor
KAS13	Allogenic transplantation of kidney from cadaver donor
KAS20	Allogenic transplantation of kidney from living donor with minimally invasive technique
KAS23	Allogenic transplantation of kidney from living donor with minimally invasive technique
KAS40	Excision of transplanted kidney
KAS50	Nephrocystostomy in transplanted kidney
KAS60	Operation for lymphocele of transplanted kidney
KAS96	Other transplantation of kidney or related procedure
KAW96	Other operation on kidney or pelvis of kidney

Table 17. NCSP-N codes for procedures on other urinary and male genital organs: ureter, bladder, urethra, prostate and seminal vesicles

Code	Title
KBA00	Exploration of ureter
KBA10	Exploratory ureterotomy
KBA96	Other exploration of ureter
KBB00	Biopsy of ureter
KBC00	Ureterectomy
KBD00	Partial excision of ureter
KBD20	Destruction of tumour of ureter
KBD30	Excision of stump of ureter
KBD96	Other partial excision of ureter or destruction of tumour of ureter
KBE00	Ureterolithotomy
KBE96	Other operation for calculus of ureter
KBF00	Removal of foreign body from ureter
KBH00	Suture of ureter
KBH06	Ureteroureterostomy
KBH10	Connection of ureter to contralateral ureter
KBH20	Replantation of ureter
KBH30	Ileal replacement of ureter
KBH40	Plastic repair of ureter
KBH50	Ureterolysis
KBH96	Other repair or connection of ureter
KBJ00	Cutaneous ureterostomy
KBJ10	Cutaneous ureteroenterostomy
KBJ20	Cutaneous ureteroenterostomy with reservoir
KBJ40	Ureteroenterostomy
KBJ60	Anastomosis of ureter to urethra with interposition of ileum
KBJ70	Removal of calculus from ileal conduit or reservoir
KBJ80	Operation for malfunction of urinary diversion
KBJ96	Other urinary diversion from ureter or related operation
KBV00	Insertion of stent into ureter
KBV10	Removal of stent from ureter
KBV40	Incision or excision of ureterocele
KBW96	Other operation on ureter
KCA00	Exploratory cystotomy
KCB00	Biopsy of bladder
KCC00	Cystectomy
KCC10	Cystoprostatectomy
KCC20	Cystoprostatourethrectomy
KCC30	Cystectomy with excision of female internal genital organs
KCC96	Other cystectomy
KCD10	Partial cystectomy
KCD20	Excision of diverticulum of bladder
KCD30	Destruction of tumour of bladder

Code	Title
KCD40	Excision of urachus or other vesicocutaneous fistula
KCD96	Other partial excision or destruction of tumour of bladder
KCE00	Cystolithotomy
KCF00	Cystotomy and removal of foreign body from bladder
KCH00	Suture of bladder
KCH10	Enterocystoplasty
KCH20	Reduction cystoplasty
KCH30	Closure of vesicointestinal fistula
KCH40	Incision or resection of bladder neck
KCH96	Other reconstructive operation on bladder
KCJ00	Cystostomy
KCJ10	Cutaneous cystoenterostomy
KCJ20	Continent cutaneous cystoenterostomy
KCJ96	Other cystostomy
KCV10	Denervation of bladder
KCV20	Freeing of bladder
KCW96	Other operations on bladder
KDC00	Urethrectomy
KDD00	Partial excision of urethra
KDD10	Excision of diverticulum of urethra
KDD30	Destruction of tumour of urethra
KDD40	Resection of external sphincter of urethra
KDD50	Excision of urethral valve
KDD80	Partial excision of urethra and repair using graft or flap
KDD96	Other partial excision of urethra
KDG00	Retropubic suspension of urethra
KDG20	Abdominal colposuspension
KDG30	Suprapubic sling urethrocystopexy
KDG40	Suprapubic urethrocystopexy
KDG43	Transobturatorial sling urethrocystopexy
KDG50	Transabdominal plastic repair of pelvic floor for urinary incontinence
KDG60	Implantation of adjustable expander around bladder neck
KDG70	Exploration of urethra
KDG96	Other operation on urethra or bladder neck for incontinence
KDH00	Suture of urethra
KDH10	Meatoplasty of urethra
KDH30	Closure of urethrocutaneous fistula
KDH50	Closure of urethrointestinal fistula
KDH70	Plastic repair of stricture of urethra
KDH96	Other reconstructive operation on urethra
KDJ00	Urethrostomy
KDK00	Implantation of artificial urinary sphincter around bladder neck
KDK10	Implantation of artificial urinary sphincter around bulbar urethra
KDK30	Revision of artificial urethral sphincter

Code	Title
KDK40	Removal of artificial urethral sphincter
KDW96	Other operation on urethra
KEA00	Exploration of prostate
KEA10	Prostatotomy
KEA20	Incision of seminal vesicle
KEB00	Biopsy of prostate
KED96	Other partial excision of prostate
KEE00	Prostatalithotomy
KEE10	Removal of foreign body from prostate
KEW96	Other operation on prostate or seminal vesicle

Table 18- NCSP-N codes for procedures on female genital organs: ovary, fallopian tube, uterus and uterine ligaments

Code	Title
LAA00	Puncture of ovarian cyst
LAB00	Ovariotomy
LAB10	Biopsy of ovary
LAB96	Other incision or biopsy of ovary
LAC00	Excision of ovarian cyst
LAC10	Fenestration of ovarian cyst
LAC20	Destruction of lesion of ovary
LAC30	Excision of paraovarian cyst
LAC96	Other excision or destruction of lesion of ovary
LAD00	Partial excision of ovary
LAE10	Unilateral oophorectomy
LAE20	Bilateral oophorectomy
LAF00	Unilateral salpingo-oophorectomy
LAF10	Bilateral salpingo-oophorectomy
LAF20	Unilateral transvaginal salpingo-oophorectomy
LAF30	Bilateral transvaginal salpingo-oophorectomy
LAG00	Freeing of adhesions of ovary
LAG10	Oophoropexy
LAG20	Detorsion of ovary
LAG96	Other reconstructive operation on ovary
LAW96	Other operation on ovary
LBB00	Biopsy of Fallopian tube
LBB96	Other biopsy of Fallopian tube
LBC10	Removal of products of conception from Fallopian tube
LBC20	Salpingotomy and removal of products of conception
LBC96	Other tube conserving operation for tubal pregnancy
LBD00	Partial excision of Fallopian tube
LBE00	Salpingectomy
LBF00	Perfusion of Fallopian tube

Code	Title
LBF03	Perfusion of Fallopian tube after reconstruction
LBF20	Transcervical catheter salpingoplasty
LBF30	Salpingolysis
LBF40	Fimbrioplasty
LBF50	Salpingostomy
LBF60	Partial excision and anastomosis of Fallopian tube
LBF70	Partial excision and reimplantation of Fallopian tube
LBF96	Other operation on Fallopian tube for infertility
LBW96	Other operation on Fallopian tube
LCA00	Biopsy of uterus or uterine ligaments
LCB00	Hysterotomy
LCB10	Myomectomy
LCB96	Other excision of lesion of uterus
LCC00	Partial excision of uterus
LCC10	Supravaginal hysterectomy
LCC20	Vaginal supravaginal hysterectomy
LCC96	Other partial excision of uterus
LCD00	Hysterectomy
LCD10	Vaginal hysterectomy
LCD30	Radical hysterectomy
LCD40	Radical vaginal hysterectomy
LCD96	Other hysterectomy
LCE00	Anterior exenteration of female pelvis
LCE10	Posterior exenteration of female pelvis
LCE20	Total exenteration of female pelvis
LCE96	Other exenteration of female pelvis
LCF00	Excision of lesion of parametrium
LCF10	Excision of female varicocele
LCF96	Other excision of lesion of parametrium
LCG10	Suture of uterus
LCG20	Hysteropexy
LCG30	Resection or transcision of sacrouterine ligaments
LCG40	Reconstruction of uterus
LCG96	Other reconstructive operation on uterus
LCW96	Other operation on uterus and uterine ligaments

Table 19. NCSP-N codes for procedures on the peripheral vessels of the abdomen

Code	Title
PCB20	Ligature of coeliac trunk and branches
PCB30	Ligature of superior mesenteric artery
PCB40	Ligature of renal artery
PCB99	Ligature of other visceral artery
PCC10	Suture of suprarenal or juxtarenal abdominal aorta
PCC20	Suture of coeliac trunk and branches
PCC30	Suture of superior mesenteric artery
PCC40	Suture of renal artery
PCC99	Suture of other visceral artery
PCE30	Thrombectomy or embolectomy of superior mesenteric artery
PCE40	Thrombectomy or embolectomy of renal artery
PCE99	Thrombectomy or embolectomy of other visceral artery
PCF20	Thrombendarterectomy of coeliac trunk and branches
PCF30	Thrombendarterectomy of superior mesenteric artery
PCF40	Thrombendarterectomy of renal artery
PCF99	Thrombendarterectomy of other visceral artery
PCG10	Operation for aneurysm of supracoeliac or juxtarenal abdominal aorta
PCG20	Operation for aneurysm of coeliac trunk and branches
PCG30	Operation for aneurysm of superior mesenteric artery
PCG40	Operation for aneurysm of renal artery
PCG99	Operation for aneurysm of other visceral artery
PCH10	Bypass from supracoeliac or juxtarenal abdominal aorta
PCH20	Bypass to/from coeliac trunk and branches
PCH30	Bypass from superior mesenteric artery
PCH40	Bypass from renal artery
PCH99	Bypass from other visceral artery
PCJ30	Transposition of superior mesenteric artery
PCJ40	Transposition of renal artery
PCJ99	Transposition of other visceral artery
PCK20	Reimplantation of coeliac trunk and branches
PCK30	Reimplantation of superior mesenteric artery
PCK40	Reimplantation of renal artery
PCK50	Reimplantation of inferior mesenteric artery
PCK99	Reimplantation of other visceral artery
PCN20	Plastic repair of coeliac trunk and branches
PCN30	Plastic repair of superior mesenteric artery
PCN40	Plastic repair of renal artery
PCN99	Plastic repair of other visceral artery
PCU70	Exploration of previous reconstruction of suprarenal abdominal aorta or visceral arteries
PCU74	Thrombectomy or embolectomy in bypass from suprarenal abdominal aorta and visceral arteries
PCU81	Closure of persisting arteriovenous fistula of bypass from suprarenal abdominal aorta and visceral arteries
PCU82	Plastic repair in bypass from suprarenal abdominal aorta and visceral arteries
PCU99	Other repair after previous reconstruction of suprarenal abdominal aorta and visceral arteries

Code	Title
PCW99	Other operation on suprarenal abdominal aorta and visceral arteries
PDA10	Exploration of infrarenal abdominal aorta
PDA30	Exploration of iliac artery
PDC10	Suture of infrarenal abdominal aorta
PDC30	Suture of iliac artery
PDE10	Thrombectomy or embolectomy of infrarenal abdominal aorta
PDE30	Thrombectomy or embolectomy of iliac artery
PDF10	Thrombendarterectomy of infrarenal abdominal aorta
PDF30	Thrombendarterectomy of iliac artery
PDG10	Operation on infrarenal abdominal aorta for aneurysm
PDG20	Bypass from aorta to iliac artery for aneurysm
PDG21	Bypass from aorta to bilateral iliac arteries for aneurysm
PDG22	Bypass from aorta to iliac and contralateral femoral artery for aneurysm
PDG23	Bypass from aorta to femoral artery for aneurysm
PDG24	Bypass from aorta to bilateral femoral arteries for aneurysm
PDG30	Operation on iliac artery for aneurysm
PDG35	Bypass from iliac to femoral artery for aneurysm
PDG99	Other operation for aneurysm of infrarenal abdominal aorta and iliac arteries
PDH10	Bypass from infrarenal abdominal aorta
PDH20	Bypass from aorta to iliac artery
PDH21	Bypass from aorta to bilateral iliac arteries
PDH22	Bypass from aorta to iliac and contralateral femoral artery
PDH23	Bypass from aorta to femoral artery
PDH24	Bypass from aorta to bilateral femoral arteries
PDH30	Bypass from iliac artery
PDH35	Bypass from iliac to femoral artery
PDH99	Other bypass from abdominal aorta or iliac artery
PDN10	Plastic repair of infrarenal abdominal aorta
PDN30	Plastic repair of iliac artery
PDU70	Exploration of previous reconstruction of infrarenal abdominal aorta or iliac arteries and distal connections
PDU74	Thrombectomy or embolectomy in bypass from infrarenal abdominal aorta or iliac artery
PDU81	Closure of persisting arteriovenous fistula of bypass from infrarenal abdominal aorta or iliac artery
PDU82	Plastic repair of bypass from infrarenal abdominal aorta or iliac artery
PDU99	Other repair after previous reconstruction of infrarenal abdominal aorta and iliac arteries and distal
PDW99	Other operation on infrarenal abdominal aorta and iliac arteries and distal connections
PHB23	Ligature of iliac vein
PHB30	Ligature of inferior vena cava
PHB31	Ligature of renal vein
PHB32	Ligature of portal vein
PHB33	Ligature of v. mesenterica superior
PHB34	Ligature of v. mesenterica inferior
PHB36	Ligature of v. spermatica
PHC23	Suture of iliac vein
PHC30	Suture of inferior vena cava

Code	Title
PHC31	Suture of renal vein
PHC32	Suture of portal vein
PHC33	Suture of v. mesenterica superior
PHC34	Suture of v. mesenterica inferior
PHD30	Resection of inferior vena cava
PHD32	Resection of portal vein
PHD33	Resection of v. mesenterica superior
PHD34	Resection of v. mesenterica inferior
PHD36	Resection of v. spermatica
PHE23	Thrombectomy of iliac vein
PHE30	Thrombectomy of inferior vena cava
PHE31	Thrombectomy of renal vein
PHH25	Bypass from iliac vein
PHH30	Bypass from inferior vena cava
PHN30	Plastic repair of inferior vena cava
PHN32	Plastic repair of portal vein
PHN33	Plastic repair of v. mesenterica superior
PHN34	Plastic repair of v. mesenterica inferior
PHW35	Portosystemic shunt or bypass

The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	Title	RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	Title and abstract Abstract l 21 Title and abstract l 20-21 No linkages between databases
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported	Introduction, l 49-73		
Objectives	3	State specific objectives, including any prespecified hypotheses	Introduction, l 74-79		
Methods					
Study Design	4	Present key elements of study design early in the paper	Abstract, l 20-30.		
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Materials and methods		
Participants	6	*(a) Cohort study* - Give the eligibility criteria, and the	Materials and methods, l. 81-82	RECORD 6.1: The methods of study population selection (such as codes or	Materials and methods, l 96-109.

		sources and methods of selection of participants. Describe methods of follow-up *Case-control study* - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants *(b) Cohort study* - For matched studies, give matching criteria and number of exposed and unexposed *Case-control study* - For matched studies, give matching criteria and the number of controls per case	and l 96-109	algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	All codes are listed in the Supplementary File References to validation studies are given in Introduction, l 66-69, and in Discussion, l 196 Not considered relevant
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	Materials and methods, l 96-109, and Supplementary File. Model variables are specified in Statistical methods, l. 115-120	RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	Codes are listed in the Supplementary File
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Covered by the above		
Bias	9	Describe any efforts to address potential sources of bias	Hospital PWD rates are risk adjusted, see		

			statistical methods l 115-120		
Study size	10	Explain how the study size was arrived at	Determined by study period		
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	Model variables are specified in Statistical methods, l. 115-120		
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses	a) See Statistical methods c) No missing data were found in final data set d) Loss to follow up assumed to be very low and uniform across hospitals e) Materials and methods, l 131-134, Results, l 173-174		
Data access and cleaning methods		..		RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population. RECORD 12.2: Authors should provide information on the data cleaning	The authors had no accesss to the NPR's databases Materials and methods, l 89-91

				methods used in the study.	
Linkage		..		RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	NPR provided linkage to National Registry using the unique PIN
Results					
Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed) (b) Give reasons for non-participation at each stage. (c) Consider use of a flow diagram	Results, l 146-151	RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	
Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders (b) Indicate the number of participants with missing data for each variable of interest (c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)	a) Results, Table 1 b) See above c) Not relevant		
Outcome data	15	*Cohort study* - Report numbers of outcome events or summary measures over time *Case-control study* - Report numbers in each exposure category, or summary measures of exposure *Cross-sectional study* - Report	Results, Table 1		

		numbers of outcome events or summary measures			
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Results, l 156-157 and Figure 1, Table 2		
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	Results, l 168-174, Figure 1		
Discussion					
Key results	18	Summarise key results with reference to study objectives	Discussion, l 176-184		
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias		RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	Discussion, l 198-218
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Conclusions, l 220-231		

Generalisability	21	Discuss the generalisability (external validity) of the study results	Discussion, l 214-218		
Other Information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	No specific funding was received		
Accessibility of protocol, raw data, and programming code		..		RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	Contact the corresponding author

*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.