demonstrated great variation in physician and hospital use of blood products [7–11].

Several studies have shown that auditing and feedback on transfusions is effective in decreasing inappropriate blood transfusions [12]. The most widely used method is a retrospective review of medical records and blood orders conducted by experts to determine appropriateness of transfusions. Practical challenges because of the limited availability of experts and funding, however, have restricted these approaches to analysis of limited time periods and limited groups of patients.

Other studies have analysed blood usage using administrative healthcare databases (e.g., Medicare data). For these analyses, blood transfusion practices for several diagnostic groups and surgeries were described using the diagnosis-related group (DRG) classification [13–16]. Comparison of the frequency and amount of blood product use and blood transfusion policies for the same diagnostic groups at different medical institutions has made it possible to identify excessive blood product use at particular institutions. If we can predict blood product use from the distribution of DRGs by using administrative data and compare them to observed use, then we may be able to screen providers whose blood usage is above average.

In 2003, Japan introduced a new medical payment system based on Japan's unique patient classification system, called the 'diagnostic procedure combination (DPC)' like the Healthcare Resource Group (HRG) in the United Kingdom, the DPC payment system consists of unique diagnostic categories emphasizing clinical classification. Hospitals those utilize DPC for medical payment use a uniform format to produce discharge summary data (i.e., DPC data). In addition to patient demographics, disease category and type of surgery, DPC data includes detailed information about type and quantity of all blood products used for each patient.

In this study, we conducted a retrospective audit of blood use at two hospitals in Japan to examine underlying conditions for blood use and appropriateness of blood transfusion in each hospital. Also, by using DPC data provided by 73 acute-care hospitals in Japan, we developed multivariate regression models to predict hospital-wide use of red blood cell (RBC) transfusions and platelet transfusions. For the two models, we assessed risk-adjusted, hospital-wide use of RBC and platelet transfusions at the hospitals studied. Furthermore, we compared the risk-adjusted use of blood products with proportions of appropriate blood use at each hospital. If the prediction model can successfully detect providers or clinical areas where blood use is above -average, then we can screen for overuse of blood use targeting a large number of hospitals and populations. Such a method is promising as a potential tool that can replace traditional audits.

Materials and methods

Data source and study subjects

This study was approved by the Medical Ethics Committee of Kyoto University in Kyoto, Japan. The protocol was approved by the Institutional Review Board (IRB) of Kyoto University Graduate School of Medicine. Data were extracted from the Quality Indicator/Improvement Project (QIP). QIP collects DPC data from institutions and analyses healthcare processes, patient outcomes and disease management to provide feedback to participating hospitals. Hospitals in the QIP voluntarily join the project, and represent a variety of public, private, teaching and non-teaching hospitals with different case-mixes and specialties. A total of 75 hospitals participated in the project. Excluding two hospitals whose healthcare claim data were incomplete, a total of 73 hospitals were included in the analyses.

Diagnostic procedure combination data are created for each patient per hospitalization. The primary classifier in the record was the DPC code (one field), which is determined by the disease that consumed the largest amount of medical resources. The DPC code contains 14 digits; the first 10 digits represent the combination of disease category and surgical procedure; the last four digits represent comorbidities, complications, age of patients (in some diagnostic groups) and expensive treatment such as chemotherapy, artificial ventilation and central venous catheters. In addition to the hospital and patient identifier and the DPC code, data included items such as the final diagnosis (one field), primary diagnosis (one field), secondary diagnosis (one field), comorbidities and complications (nine fields) and surgery information (seven fields for each surgical procedure, involving ≤ 5 surgeries).

By combining medical claim data to clinical data, it was possible to know the specific conditions for use of transfusions and details on the type, amount and other information on blood products transfused. From the DPC database, we selected approximately 661 000 consecutive records of patients discharged from 73 hospitals in Japan between April 2006 and March 2008. These records were represented the sample analysed in this study. Approximately 74 300 cases, in which patients were under 20-years old, were excluded. A total of 587 045 cases were included in the analyses.

Analyses of blood transfusion practices and identification of risk factors

We conducted a retrospective audit of blood product use in two (Hospital A and Hospital B) of the 73 hospitals studied, and surveyed underlying conditions for which transfusions were performed. These two hospitals were among eight hospitals that have participated in QIP since its inception;

both have more than 700 beds, and are teaching hospitals. Targets of audits were consecutive patients who received RBC or platelet transfusions during hospitalization and were discharged from the hospitals between July 2006 and September 2006. These patients were identified from the database, as well as from lists of patients transfused at the hospitals. Five of the authors (M.S, Y.I, T.S, H.S and K.Y) participated in the chart review. Through reviews of medical records, reviewers identified conditions (clinical course, findings of physical examinations and laboratory tests) in which a blood product was used. From the information collected, we attempted to determine the appropriateness of blood product use. Appropriateness was judged based on the 'Guidelines for blood transfusions' developed by the ad-hoc group of the Japanese Ministry of Health, Labor, and Welfare [17]. The Japanese guidelines were developed based on international guidelines and other national guidelines [2,18–21], and its recommendations are substantially similar to those of other guidelines. We also checked the accuracy of administrative claim data on timing, amount and type of blood product used. Some patients (e.g., those with haematopoietic diseases or chronic anaemia) received more than one blood transfusion during their hospitalization. For these cases, we reviewed the first episode of transfusion and judged the appropriateness of the transfusion decision. Differences in judgment were discussed among reviewers and one external expert until a final agreement on appropriateness was reached. The authors fed back results of the audits to chiefs of transfusion committees of each hospital, and obtained their consent.

Through audits at the two hospitals, we identified diagnoses, surgical procedures and comorbidities underlying the use of RBC and platelet transfusions. Using the ICD-10 code and surgical procedure classification code from the Ministry of Health and Welfare in Japan, 2006), we surveyed the frequency of these risk factors in the database, as well as proportions of transfused patients among patients with each risk factor.

Logistic regression model to predict proportions of transfused patients at hospitals

Using DPC data of 587 045 cases provided by 73 acute-care hospitals, we developed a multiple logistic regression model to predict proportions of transfused patients at each hospital. In this model, the dependent variable, the occurrence of blood transfusion during hospitalization, was defined as a binary variable. Each case received at least one blood transfusion during hospitalization was classified as '1; Used'. Each case that did not receive any blood transfusions during hospitalization was classified as '0; Not used'. Independent variables included risk factors, which either were identified through chart reviews at the two hospitals or were reported in previous studies to be associated with the risk of transfusion [14–16,22]. Performance of the logistic regression model was assessed by calculating the area under the receiver operating characteristic (ROC) curve. The area under a ROC curve relating relative proportions of correctly and incorrectly classified predictions over a wide and continuous range of threshold levels can measure discrimination capacity of the prediction rule [23,24]. Using the regression model, we calculated expected proportions of patients transfused at each hospital. By comparing observed (O) and expected (E) values, we calculated O/E ratios.

Case-mix adjusted model to predict total units of blood products transfused from the distribution of diagnostic groups at hospitals

The second model utilized the distribution of diagnostic groups to predict the total units of RBCs or platelets transfused at each hospital. In this model, we calculated the mean units of blood products used per case for each diagnostic group (defined by the first 10 digits, representing disease code + surgical code), and used these mean values as expected values for RBC or platelet use in that diagnostic group. All cases in each group were used to calculate means. Mean units used per case in the ith group can be represented by $Q(i)$, the number of cases belonging to that group can be represented by $M(i)$, and the total number of diagnostic groups can be represented by W. Thus, the expected total units of blood product used in the hospital can be described by the following formula:

$$\sum_{i=1}^{W} \{Q(i) \times N(i)\}$$

From the distribution of diagnostic groups in each hospital, we estimated total units of RBCs or platelets used at the hospital. By comparing expected and observed values, we calculated O/E ratios for total units transfused at each hospital. Predictive ability of this model was assessed by the correlation coefficient, r^2. Moreover, we compared results of the retrospective audit with O/E ratios. To assess case-mix adjusted blood product use, expected total RBC or platelet use was compared with observed values to obtain observed to expected ratios (O/E ratios) at each hospital. We used SPSS (Version 11, SPSS Inc.) for all statistical analyses.

Results

Risk factors of blood transfusion

Table 1 shows characteristics of the hospitals in Japan that were studied, as well as the frequency and amount of RBC products and concentrated platelets transfused at the

Table 1 Characteristics of 73 studied hospitals and the distribution of blood products use in each hospital

Factor	Range	Percentile		
		25%	50%	75%
No of bed	43–1106	239	350	530
No of hospitalization (month)	93–2468	361	559	953
Mean length of stay (days)	9·6–41·0	13·2	15·2	18·2
Hospital mortality rate (%)	0·1–8·8%	3·4	4·5	5·2
No of patients with RBC transfusion (100 beds/month)	0·8–22·6	5·2	7·5	10·1
No of patients with PLT transfusion (100 beds/month)	0–6·1	0·65	1·2	2·4
All RBC units transfused (Units/100 beds/month)	2·7–228·6	33·3	50·2	73·7
All PLT units transfused (Units/100 beds/month)	0–499·3	19·1	45·7	120·0

RBC, red blood cell; PLT, platelet.

hospitals. Of the 587 045 cases targeted, 33 155 (5·7%) patients received RBC transfusions, and 7065 (1·2%) patients received platelet transfusions. Frequency of blood transfusion and number of units transfused per patient-bed varied greatly between hospitals. Based on retrospective audits at two hospitals (Hospitals A and B), Table 2 summarizes underlying conditions for use of RBC and platelet transfusions, as well as appropriateness of blood transfusions at each hospital.

From the retrospective audit, we identified patient characteristics, diagnoses and surgical procedures potentially associated with risk of blood transfusion. Table 3 shows the distribution of these potential risk factors in 587 045 cases in the database, as well as the probability of receiving ≥ 1 transfusion during hospitalization of the population with each risk factor. Cases with the risk were identified using the disease classification (ICD-10) code and surgery classification code (from the fee schedule system for medical reimbursement by the Ministry of Health and Welfare, Japan). Factors with the greatest risk for RBC transfusion included cardiovascular surgeries, haematopoietic malignancies, aplastic anaemia and myelodysplastic syndrome (MDS). Factors with the greatest risk for platelet transfusion included blood diseases such as acute leukaemia, aplastic anaemia and MDS, as well as cardiovascular surgery.

Logistic regression models predicting proportions of patients with transfusions

Table 4 shows risk factors for RBC and platelet transfusions and coefficients and odds ratios (ORs: 95% confidence intervals) of multiple logistic regression analyses. Greatest

Table 2 Underlying conditions of transfusion and proportions of appropriate transfusion

Underlying condition	Hospital A				Hospital B			
	n	%	Appropriate transfusion	%	*n*	%	Appropriate transfusion	%
RBC transfusion								
Acute bleeding	52	20	43	83	43	16	33	77
Perioperative								
Cardiovascular surgery	39	15	24	62	35	13	25	71
Others	55	21	30	55	50	19	33	66
Chronic anaemia								
Haematopoietic malignancies/ disorders	35	14	26	74	67	25	60	90
Others	52	20	40	77	47	18	42	89
Chronic bleeding	24	9	23	96	24	9	23	96
All	257	100	186	72	266	100	216	81
Platelet transfusion								
Haematopoietic malignancies/ disorders	30	38	4	13	51	59	40	78
Cancer	11	14	9	82	8	9	4	50
Surgery								
Cardiovascular surgery	23	29	4	17	12	14	10	83
Others	5	6	3	60	4	5	0	0
Others	10	13	3	30	12	14	2	17
All	79	100	23	29	87	100	56	64

GI indicates gastrointestinal; MDS. Myelodysplastic syndrome; RBC, red blood cell.

Table 3 Prevalence of risk factors of transfusion and proportions of patients transfused during hospitalization

Factor	*n*	Prevalence (1000 admissions)	Proportion of patients with transfusion: RBC transfusion (%)	Proportion of patients with transfusion: PLT transfusion (%)
Age				
20–64	259588	442·2	3·5	1·0
65–79	220247	375·2	6·5	1·5
80+	107210	182·6	9·0	1·1
Blood disorders				
Acute leukaemia	1986	3·4	59	60
Chronic leukaemia	476	0·8	28	16
Malignant lymphoma	1625	2·8	36	17
Multiple myeloma	6032	10·3	14	11
Aplastic anaemia	940	1·6	58	34
MDS	1476	2·5	63	37
DIC	4372	7·4	43	26
Cancer*				
Without chemotherapy	93103	158·6	8·3	0·8
With chemotherapy	42088	71·7	4·7	1·0
Surgery				
Cardiovascular surgery				
Without CPB	2205	3·8	50	18
With CPB	2629	4·5	73	43
Hip fracture surgery	7457	12·7	28	0·9
Severe trauma				
Obstetric bleeding	823	1·4	10	1·5
GI bleeding	19808	33·7	34	2·5
Chronic renal failure	24691	42·1	17	2·1

GI, gastrointestinal; DIC, disseminated intravascular coagulation; CPB, cardiopulmonary bypass; MDS. Myelodysplastic syndrome; RBC, red blood cell.

risk factors for RBC transfusion were cardiovascular surgery with cardiopulmonary bypass (CPB) (OR = 106·9), followed by acute leukaemia (OR = 46·9), MDS (OR = 39·2), cardiovascular surgery without CPB (OR = 35·0), gastrointestinal haemorrhage (OR = 13·2), and hip fracture surgery (OR = 11·0). Risk of RBC transfusion increased with patient age.

Greatest risk factors for platelet transfusion were acute leukaemia (OR = 310) and cardiovascular surgery with CPB (OR = 185), followed by MDS (OR = 78·9), cardiovascular surgery without CPB (OR = 46·5), disseminated intravascular coagulation (DIC) (OR = 43·2), multiple myeloma (OR = 39·5) and aplastic anaemia (OR = 33·6). No association was observed between patient age and risk of platelet transfusion.

These logistic regression models showed good prediction performances. Areas under ROC curves for proportions of patients with RBC transfusions and platelet transfusions were 0·83 and 0·90, respectively.

Case-mix adjusted models predicting total units of blood products used

Figure 1 shows expected vs. observed use of RBCs and platelets at each hospital. The goodness-of-fit of this model, assessed using r^2 for linear regression, was 0·88 for RBC use and 0·57 for platelet use. Therefore, use of blood products at each hospital was successfully predicted by the case-mix adjusted model.

Table 5 compares results of the medical chart review (percentage of appropriateness) and O/E ratios calculated using the two prediction models. In general, proportions of appropriate transfusions were higher for RBC than for platelet transfusions. Also, Hospital B showed better performance in terms of appropriate transfusions than did Hospital A. Both models successfully assessed the proportion of appropriate transfusions.

Discussion

Due to critical situations and complex clinical conditions underlying the use of blood products, it is often difficult for physicians to make appropriate decisions about blood transfusions. Surveys of blood product usage for specific diagnoses have demonstrated wide variation in comparable patients at different institutions [8,26–29]. Some studies have shown that a system approach is effective for improving transfusion practices. System approaches include implementation of institutional guidelines, education, prospective audits and approval of transfusion orders [12]. Of these approaches, 'clinical audits' with feedback can effectively decrease the amount of blood product used [28–35]. However, these effects on blood product use are often temporary, and continuous efforts are required for maintenance of good transfusion practices [30,36]. Moreover, audits require considerable labour and cost. Therefore, it is difficult to implement audits for routine and continuous evaluations. If another method were available for routine evaluations, then it would contribute greatly to comparison of transfusion performance between hospitals and resultant improvement in transfusion practices at hospitals.

We proposed methods which utilizing administrative data to evaluate hospital-wide use of blood products in Japan. Few studies have employed administrative data to perform such comparisons. Comparison of blood usage across hospitals usually is difficult given that risks of transfusion differ between patients and between hospitals. On the contrary, some studies have demonstrated that a patient classification

Table 4 Logistic regression models for predicting transfusion of red blood cell and platelet

Factor	RBC			PLT		
	Regression coefficient	Odds ratio	95% CI	Regression coefficient	Odds ratio	95% CI
Age*						
65–74	0·40	1·5	1·4–1·5	0·11	1·1	1·0–1·2
80+	0·75	2·1	2·1–2·2	−0·06	0·9	0·9–1·0
Female	−0·12	0·89	0·86–0·91	0·06	1·1	1·0–1·1
Haematopoietic disorders						
Acute leukaemia	3·85	46·9	42·4–51·8	5·74	310	278–346
Chronic leukaemia	2·33	10·3	8·1–12·9	3·26	26·2	19·2–35·6
Aplastic anaemia	3·12	22·7	19·4–26·6	3·52	33·6	27·3–41·4
Multiple myeloma	2·84	17·2	15·4–19·2	3·68	39·5	33·8–46·1
Malignant lymphoma	1·51	4·5	4·1–4·9	3·10	22·2	20·0–24·7
MDS	3·67	39·2	34·9–44·1	4·37	78·9	68·6–90·7
DIC	2·44	11·4	10·6–12·3	3·77	43·2	39·3–47·5
Obstetric bleeding	1·82	6·2	4·9–7·8	0·99	2·7	1·4–5·0
Severe trauma	2·65	14·1	12–16·6	2·08	8·0	5·9–11
Cardiovascular surgery						
Without CPB	3·56	35·0	32·0–38·3	3·84	46·5	40·8–52·9
With CPB	4·67	106·9	97·7–117	5·22	185	169–203
Malignant tumour						
Without chemotherapy	0·93	2·5	2·5–2·6	0·32	1·4	1·3–1·5
With chemotherapy	0·66	1·9	1·8–2	0·81	2·2	2·0–2·5
GI bleeding	2·58	13·2	12·8–13·7			
Hip fracture surgery	2·40	11·0	10·4–11·6			
Chronic renal failure	1·59	4·90	4·7–5·1			
Liver cirrhosis				1·25	3·5	3·0–4·0
Constant	−4·10			−5·78		

GI, gastrointestinal; DIC, disseminated intravascular coagulation; CPB, cardiopulmonary bypass; MDS. Myelodysplastic syndrome; RBC, red blood cell 95% CI, 95% confidence intervals for odds ratios.

system such as DRG can provide a means for inter-institutional benchmarking and cost comparison [14–16,37]. DRG is widely used for healthcare payments and analyses of hospital activities. The basic concept underlying the employment of DRG for reimbursement is that 'treatments for similar patients consume a similar degree of medical resources'. Therefore, patients within the same DRG are considered to have similar resource (e.g., blood product) utilization.

By the use of a patient classification system and identification of risk factors of transfusion, we can properly compare blood product use between different healthcare providers. Furthermore, such a method should be useful for identifying providers with extremely high levels of blood product use. If a simple risk adjustment model could be developed by analyzing large healthcare databases representing information obtainable with little labour and at low

COLOUR

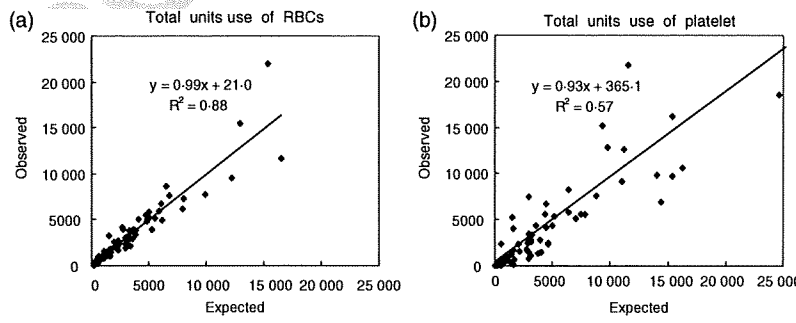


Fig. 1 The multiple linear regression model to predict total unit use of RBCs and platelets transfused at each hospital

Table 5 Results of the medical chart review (percentage of appropriateness) and O/E ratios calculated using the two prediction models

		Red blood cell			Platelet		
Patient	Hospital	% of appropriateness	O/E (Model 1)	O/E (Model 2)	% of appropriateness	O/E (Model 1)	O/E (Model 2)
Overall	A	72	1·09 (1·02–1·18)	1·11 (1·05–1·16)	35	1·54 (1·34–1·81)	1·60 (1·41–1·83)
	B	81	0·93 (0·89–0·93)	0·78 (0·75–0·81)	64	1·13 (1·03–1·25)	0·78 (0·75–0·89)
Haematopoietic malignancy	A	71	1·35 (1·11–1·72)	1·61 (1·40–1·90)	25	1·50 (1·19–2·00)	2·30 (1·91–2·89)
	B	91	1·09 (0·97–1·25)	0·90 (0·82–0·99)	78	1·17 (1·02–1·36)	0·78 (0·75–0·89)
Cardiovascular surgery	A	62	1·25 (1·08–1·48)	1·73 (1·52–2·01)	17	1·76 (1·35–2·53)	1·23 (1·04–1·52)
	B	71	0·96 (0·88–1·05)	0·86 (0·79–0·93)	83	0·99 (0·85–1·18)	0·95 (0·86–1·06)

cost, it would be possible to evaluate the frequency of blood product use by various healthcare providers. It should be noted, however, that such a method is not designed to replace the detailed analyses conducted by auditing committees. Instead of pinpoint evaluations on blood product utilization at the patient level, the purpose of our method is to provide continuous surveillance and routine general evaluations on a larger scale that allows for multi-institutional comparisons with a satisfactory level of accuracy.

We selected two indicators to evaluate hospital-wide use of blood products in Japan: (i) proportion of patients that received a blood transfusion and (ii) total amount (number of units) of blood products used. These are typical indicators used for assessment of hospital-level blood usage [9,16,25,26]. We developed two regression models to calculate risk-adjusted blood use. A logistic regression model was used to predict the percentage of transfused patients in each hospital. A multiple linear regression model was used to predict hospital-wide total units of RBCs or platelets transfused.

With a limited number of variables, the logistic regression model could effectively predict proportions of patients that received a blood transfusion. Our predictive model consisted of 19 variables that were easily collected from healthcare data in Japan. In the database of approximately 587 000 cases used for the study, the amount of blood products used for patients with any of these risk factors represented 80–90% of the total amount of blood products used. The multiple linear regression model used distribution of diagnostic groups to predict total unit use of RBCs and platelets transfused at each hospital. Although both models showed good prediction abilities, the logistic regression model better predicted RBC use than platelet use. Also, the multiple linear regression model better predicted RBC use than platelet use (Fig. 1).

The following issues should be noted when evaluating blood product use with O/E ratios. First, the mean value of the group is used as the reference value (expected value) when performing evaluations with O/E ratios, thus the evaluation is relative. For instance, if blood product use in the entire group is excessive, there is a possibility that the O/E ratio will be <1 in hospitals with high blood product use. Second, when O/E ratios are low, it is difficult to distinguish whether this is a result of appropriate blood product use, or under use. However, with blood transfusions, over use and misuse of blood product have been more of a problem than under use. Thus, when use is higher than average, there is a high likelihood that there has been inappropriate blood product use. On the contrary, when use is lower than average, there is a possibility that the healthcare provider is transfusing the bare minimum required.

Actually, O/E ratios calculated by use of the two models were very relevant to proportions of appropriate blood use (Table 5). Larger O/E ratios were associated with a smaller proportion of appropriate transfusions as judged by medical chart reviews. No particular difference was seen between the O/E ratio for proportion of patients receiving transfusions and that for the total amount (number of units) of RBC use. Both methods were considered to have successfully evaluated appropriate blood use.

Based on these findings, we conclude that the assessment of blood product use employing O/E ratios can be used, not only as an index for valid and appropriate transfusions but also as an index for blood product use that takes patient risk into consideration. Additionally, our research strongly indicates that valid comparisons may be made across hospitals in Japan.

Evaluation of blood product use at the hospital level is important in several ways. Wide variation in blood product use exists among hospitals. By comparing blood product use in different hospitals, risk-adjusted assessment of blood product use has the potential to contribute towards appropriate use of blood products [7,10,25]. Because of the labour and cost involved in gathering data on blood product use, however, almost no previous attempts had been made to collect and analyse data from many hospitals in Japan. DPC data are advantageous, as it gathers into a unified format the clinical information and data on

treatment procedures for all hospitalized patients. Therefore, it is possible to use a shared assessment standard to compare conditions for blood product use between hospitals, and to engage in discussion about clinical standards.

Acknowledgments

The authors are grateful to Dr Yasunori Ueda (Kurashiki Central Hospital, Kurashiki) for his comments on our article. We also thank to Dr Osamu Yonekawa (Seirei Hamamatsu General Hospital) for his supports to this study.

4,5 References

1 American Red Cross: Practice guidelines for blood transfusion: a compilation from recent peer-reviewed literature. May 2002. (available at http://www.redcrossblood.org/portal/SC/pdf/hospitals/pgbt_print.pdf)

2 The Task Force on Blood Component Therapy: Practice guidelines for blood component therapy. *Anesthesiology* 1996; 85:1219–1220

3 Baele PL, Muylle L, Noens L, Gulliksson H, Brands A, Isbister J, Van der Linden P, Hübner R, Berneman Z, Lamy M, Ferrant A, Lambermont M, Sondag D: Guidelines for the transfusion of red cells. *Acta Clin Belg* 2008; 63:301–312

4 O'Shaughnessy DF, Atterbury C, Bolton Maggs P, Murphy M, Thomas D, Yates S, Williamson LM, British Committee for Standards in Haematology, Blood Transfusion Task Force: Guidelines for the use of fresh-frozen plasma, cryoprecipitate and cryosupernatant. *Br J Haematol* 2004; 126:11–28

5 Blood Transfusion Task Force: Guidelines for the use of platelet transfusions. British Committee for Standards in Haematology. *Br J Haematol* 2003; 122:10–23

6 Simon TL, Alverson DC, AuBuchon J, Cooper ES, DeChristopher PJ, Glenn GC, Gould SA, Harrison CR, Milam JD, Moise KJ Jr, Rodwig FR Jr, Sherman LA, Shulman IA, Stehling L: Practice parameter for the use of red blood cell transfusions: developed by the Red Blood Cell Administration Practice Guideline Development Task Force of the College of American Pathologists. *Arch Pathol Lab Med* 1998; 122:130–138

7 Gombotz H, Rehak PH, Shander A, Hofmann A: Blood use in elective surgery: the Austrian benchmark study. *Transfusion* 2007; 47:1468–1480

8 Ozier Y, Pessione F, Samain E, Courtois F, French Study Group on Blood Transfusion in Liver Transplantation: Institutuinal variability in transfusion practice for liver transplantation. *Anesth Analg* 2003; 97:671–679

9 Mathoulin-Pélissier S, Salmi LR, Verret C, Demoures B: Blood transfusion in a random sample of hospitals in France. *Transfusion* 2000; 40:1140–1146

10 Surgenor DM, Wallace EL, Churchill WH, Hao S, Hale WB, Schnitzer J: Utility of DRG and ICD-9-CM classification codes for the study of transfusion issues. Transfusions in patients with digestive diseases. *Transfusion* 1989; 29:761–767

11 Cook SS, Epps J: Transfusion practice in central Virginia. *Transfusion* 1991; 31:355–360

12 Tinmouth A, Macdougall L, Fergusson D, Amin M, Graham ID, Hebert PC, Wilson K: Reducing the amount of blood transfused: a systematic review of behavioral interventions to change physicians' transfusion practices. *Arch Intern Med* 2005; 165:845–852

13 Slonim AD, Joseph JG, Turenne WM, Sharangpani A, Luban NL: Blood transfusions in children: a multi-institutional analysis of practices and complications. *Transfusion* 2008; 48:73–80

14 Syrjälä MT, Kytöniemi I, Mikkolainen K, Ranimo J, Lauharanta J: Transfusion practice in Helsinki University Central Hospital: an analysis of diagnosis-related groups (DRG). *Transfus Med* 2001; 11:423–431

15 Jefferies LC, Sachais BS, Young DS: Blood transfusion costs by diagnosis-related groups in 60 university hospitals in 1995. *Transfusion* 2001; 41:522–529

16 Lim YA, Lee WG, Cho SR, Hyun BH: A study of blood usage by diagnoses in Korean university hospital. *Vox Sang* 2004; 86:54–61

17 Japanese Ministry of Health, Labor, and Welfare. Practice guideline for the use of blood components. 2005. (available at http://www.jrc.or.jp/vcms_lf/iyakuhin_benefit_guideline_sisin090805.pdf)

18 American College of Surgeons: Advanced Trauma Life Support Course Manual. American College of Surgeons 1997; 103–112 . 6

19 Lundsgaard-Hansen P: Component therapy of surgical hemorrhage: red cell concentrates, colloids and crystalloids. *Bibl Haematol* 1980; 46:147–69

20 British Committee for Standards in Haematology, Blood Transfusion Task Force: Guidelines for the use of platelet transfusions. *Br J Haematol* 2003; 122:10–23

21 Schiffer CA, Anderson KC, Bennett CL, Bernstein S, Elting LS, Goldsmith M, Goldstein M, Hume H, McCullough JJ, McIntyre RE, Powell BL, Rainey JM, Rowley SD, Rebulla P, Troner MB, Wagnon AH: Platelet transfusion for patients with cancer: clinical practice guidelines of the American Society of Clinical Oncology. American Society of Clinical Oncology. *J Clin Oncol* 2001; 19:1519–1538

22 Corwin HL, Gettinger A, Pearl RG, Fink MP, Levy MM, Abraham E, MacIntyre NR, Shabot MM, Duh MS, Shapiro MJ: The CRIT Study: Anemia and blood transfusion in the critically ill – current clinical practice in the United States. *Crit Care Med* 2004; 32:39–52

23 Zweig MH, Campbell G: Receiver-operating characteristic (ROC) plots: a fundamental evaluation tool in clinical medicine. *Clin Chem* 1993; 39:561–577

24 Pearce J, Ferrier S: Evaluating the predictive performance of habitat models developed using logistic regression. *Ecol Modell* 2000; 133:225–245

25 Sanguis Study Group: Use of blood products for elective surgery in 43 European hospitals. The Sanguis Study Group. *Transfus Med* 1994; 4:251–268

26 Snyder-Ramos SA, Mohnle P, Weng Y, Bottiger BW, Kulier A, Levin J, Mangano DT: The ongoing variability in blood transfusion practices in cardiac surgery. *Transfusion* 2008; 48:1284–1299

27 Stover EP, Siegel LC, Parks R, Levin J, Body SC, Maddi R, D'Ambra MN, Mangano DT, Spiess BD: Variability in

transfusion practice for coronary artery bypass surgery persists despite national consensus guidelines: a 24-institution study. Institutions of the Multicenter Study of Perioperative Ischemia Research Group. *Anesthesiology* 1998; **88**:327–333

28 Morrison JC, Sumrall DD, Chevalier SP *et al.*: The effect of provider education on blood utilization practices. *Am J Obstet Gynecol* 1993; **169**:1240–1245

29 Muller U, Exadaktylos A, Roeder C *et al.*: Effect of a flow chart on use of blood transfusions in primary hip and knee replacement: prospective and after study. *BMJ* 2004; **328**:934–938

30 Pentti J, Syrjala M, Pettila V: Computerized quality assurance of decisions to transfuse blood components to critically ill patients. *Acta Anaesthisiol Scand* 2003; **47**:973–978

31 Rehm JP, Otto PS, West WW *et al.*: Hospital-wide educational program decreases red blood cell transfusions. *J Surg Res* 1998; **75**:183–186

32 Rosen NR, Bates LH, Herod G: Transfusion therapy: improved patient care and resource utilization. *Transfusion* 1993; **33**:341–347

33 Shanberge JN: Reduction of fresh-frozen plasma use through a daily survey and education program. *Transfusion* 1987; **27**:226–227

34 Solomon RR, Clifford JS, Gutman SI: The use of laboratory intervention to stem the flow of fresh-frozen plasma. *Am J Clin Pathol* 1988; **89**:518–521

35 Soumerai SB, Salem-Schatz S, Avorn J *et al.*: A controlled trial of educational outreach to improve blood transfusion practice. *J Am Med Assoc* 1999; **270**:961–966

36 Tobin SN, Campbell DA, Boyce NW: Durability of response to a targeted intervention to modify clinician transfusion practices in a major teaching hospital. *Med J Aust* 2001; **174**:445–448

37 Rashiq S, Shah M, Chow AK, O'Connor PJ, Finegan BA: Predicting allogenic blood transfusion use in total joint arthroplasty. *Anesth Analg* 2004; **99**:1239–1244

DPCに基づく包括支払い制度導入後の乳癌治療への影響と変化

京都大学大学院医学研究科医療経済学分野[1)]
大隈和英[1)]、今中雄一[1)]、福田治久[1)]、関本美穂[1)]、
猪飼　宏[1)]、濱田啓義[1)]

第109回日本外科学会定期学術集会

研究の主旨

- 我が国の乳癌は、死亡・罹患率ともに増加傾向にあり、年間死亡数9,885人 (2003年)、罹患数は36,139人(1999年)であり、大腸がんを抜き女性の悪性腫瘍の第1位を占める。
  日本人女性の平均寿命の延長もあり、乳癌治療の重要性は益々高まっている。

- 乳癌治療は、手術治療を主体に、薬物治療、放射線治療、緩和医療に至るまで多彩であり、集学的治療の代表的なものである。その多様性の一方、「診療のばらつき」の存在を検証することは、EBMの見地から重要と思われる。

- DPC制度下の乳癌患者の治療の変化について診療情報を様々な角度から比較評価して、診療のトレンドとそれに伴う医療の質について検証する。

研究の方法

QIP
Quality Indicator/Improvement Project

- プロジェクト：QIP（Quality Indicator/Improvement Project）は、DPCデータを利用して診療のプロセス・アウトカムや経済性を反映する客観的な数値指標を開発・測定し、その情報を定期的に参加病院にフィードバックして、医療の質の向上に寄与する目的としている。前身は1995年から開始され、学内の倫理委員会の承認下、国内120以上の有力病院の参加を以って、厚労省の科研費により運営されている。

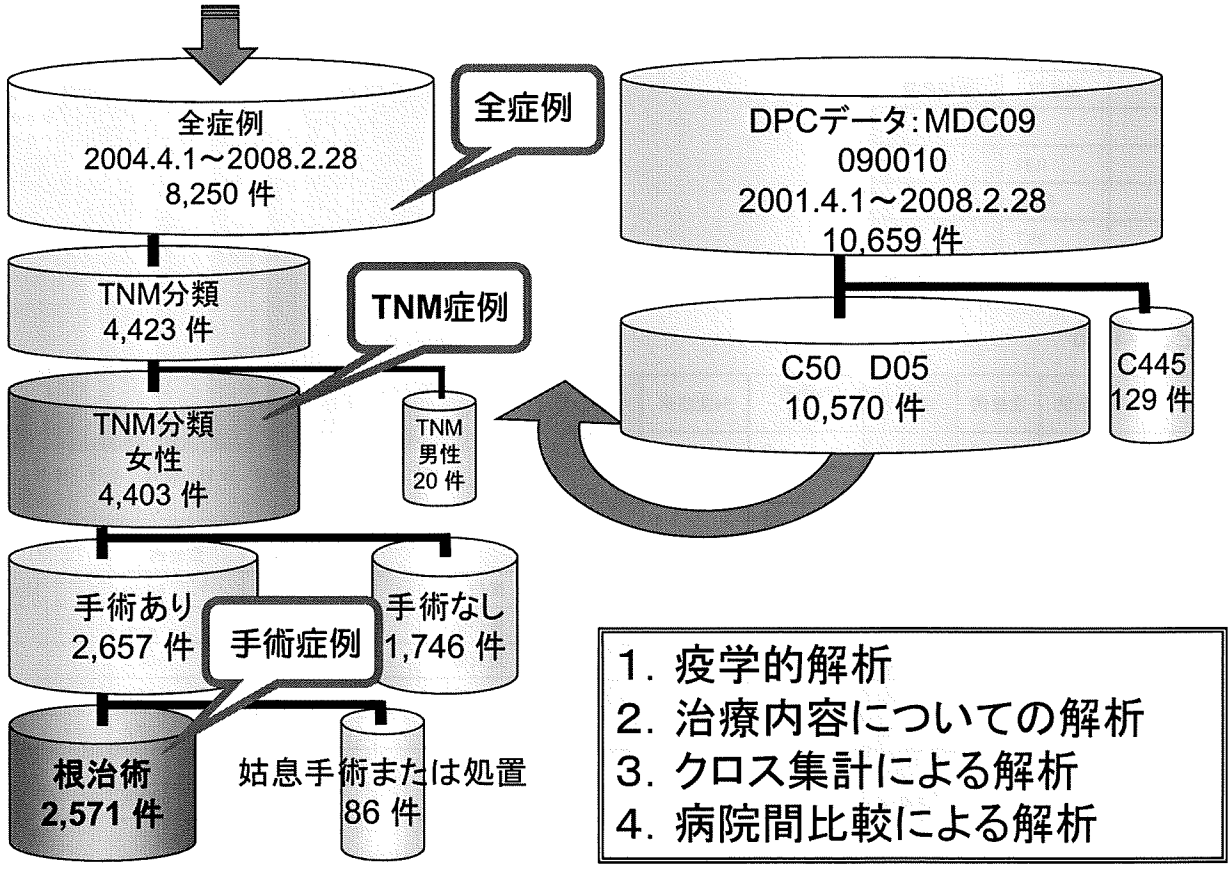
- 対象規模：QIP参加44病院のDPCデータ　10,659件

- 対象疾患：MDC09「乳房の疾患」のDPCコード090010
  ICD-10「乳癌(C50$)」または「乳房の上皮内癌(D50$)」

- 除外疾患：以下は解析から除外した。
  1. （乳房の）「皮膚のその他の悪性新生物、体幹の皮膚(C445)」
  2. 「Paget 病（）」

- データ期間：2004年4月～2008年2月

サンプルの内容



1）疫 学 的 解 析

～DPCデータの妥当性評価として『全国乳がん患者登録調査報告』（第36号 2005年次症例）との比較～

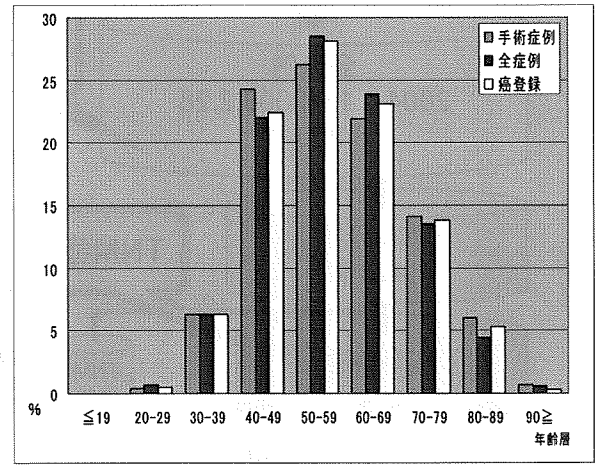
1）疫学

1．性差

	全症例	乳癌登録
男性	27	74
(%)	0.33	0.5
女性	8,223	15,816
(%)	99.7	99.5
合計	8,250	15,890

2．年齢

	手術症例	全症例	癌登録	%手術症例	%全症例	%癌登録
≦19	0	0	4	0	0	0.0
20-29	11	61	83	0.4	0.7	0.5
30-39	162	520	987	6.3	6.3	6.3
40-49	625	1819	3535	24.3	22.0	22.4
50-59	674	2353	4436	26.2	28.5	28.1
60-69	563	1969	3652	21.9	23.9	23.1
70-79	363	1116	2186	14.1	13.5	13.8
80-89	156	366	849	6.1	4.4	5.3
90≧	17	46	78	0.7	0.6	0.3
合計	2571	8250	15816	100	100	100
			不明 6			不明 0.0



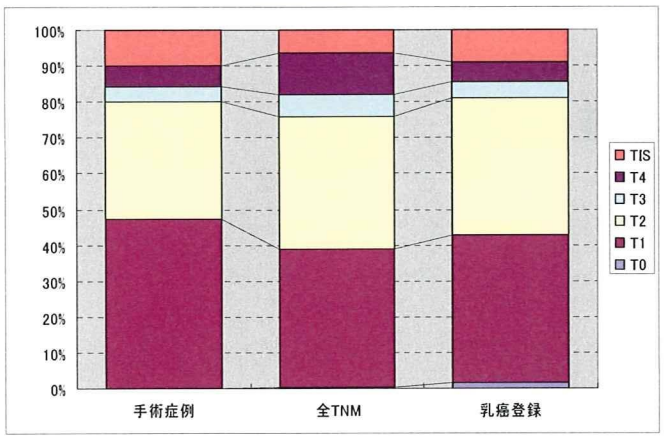
	手術症例	全症例	癌登録
度数	2,571	8,250	15,816
最小値	24.2	20.2	
最大値	96.4	102.3	
平均値	58.2	58.0	57.7
中央値	57.5	57.8	57.0
最頻値	51.4	50.1	57.0
標準偏差	13.3	12.8	13.0

我々のDPCデータの性差・年齢階層は『乳癌学会の全国乳がん患者登録調査報告 2005年版』と非常に近似する。

1）疫学

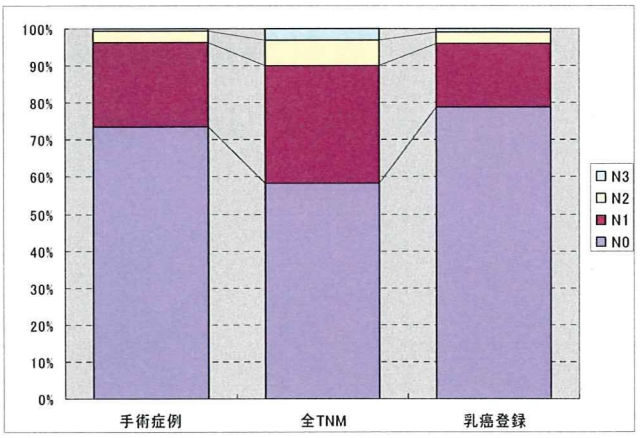
T因子

	手術症例	全TNM	乳癌登録	% 手術症例	% 全TNM	% 癌登録
T0	2	13	227	0.1	0.3	1.4
T1	1212	1700	6185	47.1	38.5	39.1
T2	845	1625	5730	32.9	36.8	36.3
T3	107	267	679	4.2	6.0	4.3
T4	147	514	812	5.7	11.7	5.1
TIS	258	284	1345	10.0	6.6	8.5
合計	2571	4403	15816	100	100	100
			不明 838			不明 5.3



N因子

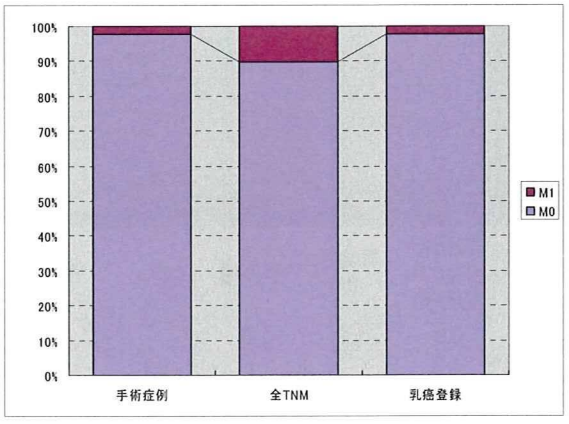
	手術症例	全TNM	乳癌登録	% 手術症例	% 全TNM	% 癌登録
N0	1890	2563	12378	73.5	58.2	78.3
N1	581	1407	2707	22.6	32.0	17.1
N2	83	292	479	3.2	6.6	3
N3	17	141	147	0.7	3.2	0.9
合計	2571	4403	15816	100	100	100
			不明 838			不明 0.7



1）疫学

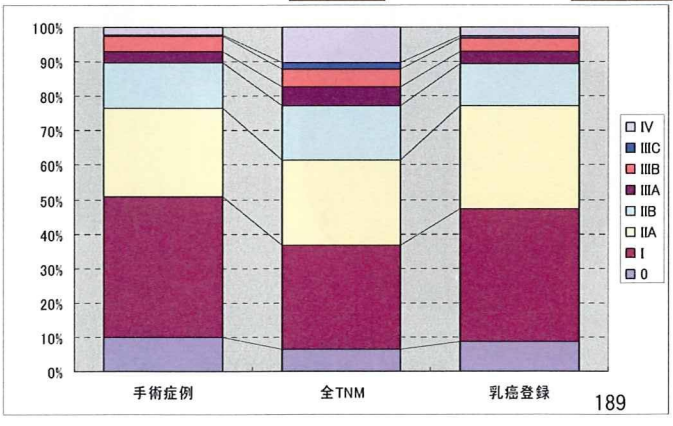
M因子

	手術症例	全TNM	乳癌登録	%手術症例	%全TNM	%癌登録
M0	2516	3952	15228	97.9	87.8	96.3
M1	55	451	357	2.1	12.2	2.3
合計	2571	4403	15816	100	100	100
			不明231			不明 1.5



病期分類

	手術症例	全TNM	乳癌登録	%手術症例	%全TNM	%癌登録
0	258	284	1280	10.0	6.5	8.1
I	1049	1332	5568	40.8	30.3	35.2
IIA	657	1083	4384	25.6	24.6	27.7
IIB	342	699	1751	13.3	15.9	11.1
IIIA	86	239	495	3.3	5.4	3.1
IIIB	112	223	602	4.4	5.1	3.8
IIIC	12	92	91	0.5	2.1	0.6
IV	55	451	357	2.1	10.2	2.3
合計	2571	4403	15816	100	100	100
			不明1288			不明 8.1



2）治　療

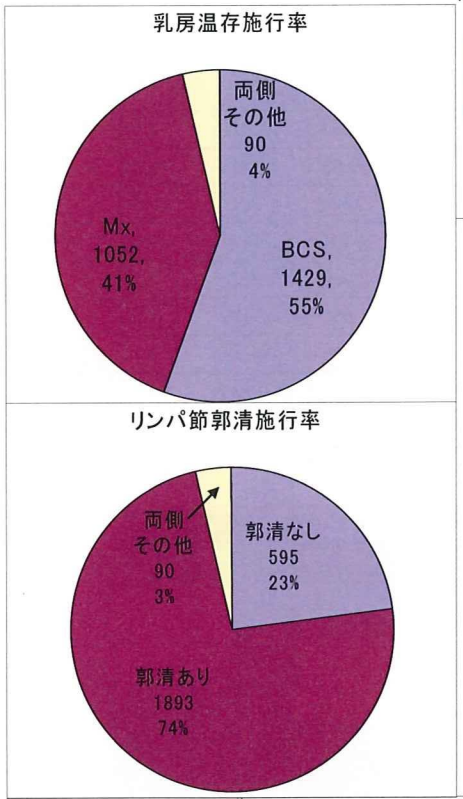
1. 手術術式

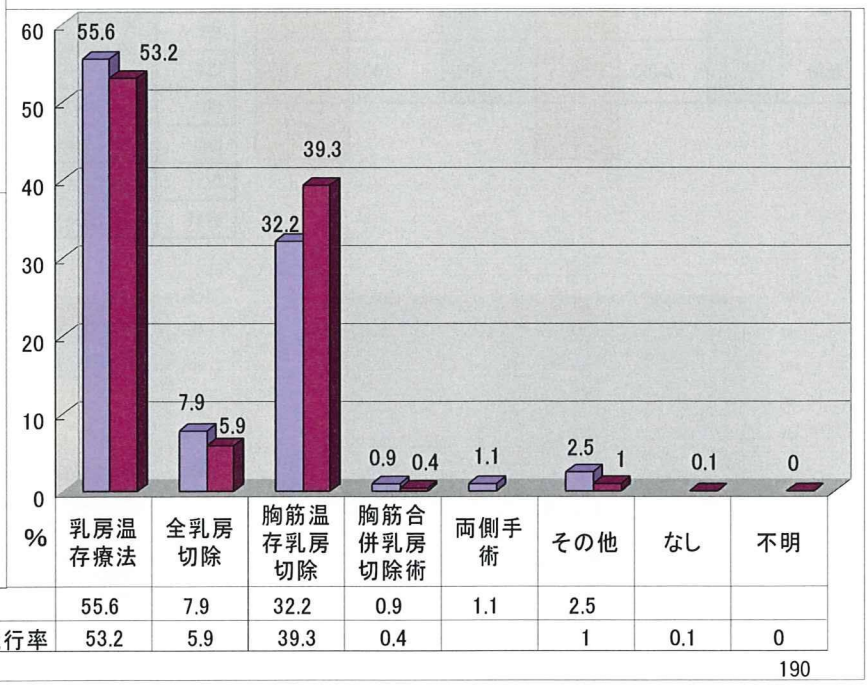
2. 術後補助療法

- 化学療法の実施状況
- 放射線療法の実施状況
- リハビリテーションの実施状況

2）治療　手術術式

我々のDPCデータにおける手術術式は『乳癌学会の全国乳がん患者登録調査報告2005年版』と非常に近似する。



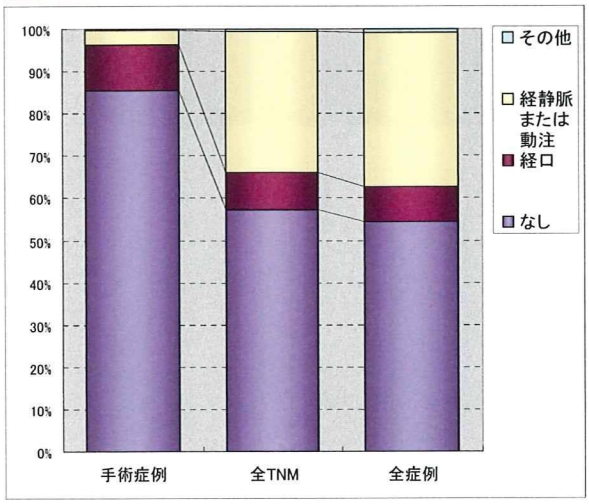


	乳房温存療法	全乳房切除	胸筋温存乳房切除	胸筋合併乳房切除術	両側手術	その他	なし	不明
QIP施行率	55.6	7.9	32.2	0.9	1.1	2.5		
乳がん登録での施行率	53.2	5.9	39.3	0.4		1	0.1	0

2）治療　術後補助療法

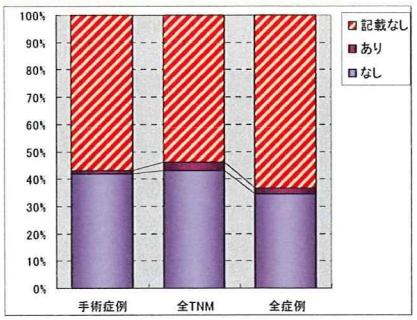
化学療法の実施状況

	手術症例	全TNM	全症例	%手術症例	%全TNM	%全症例
なし	2201	2517	4492	85.6	57.1	54.4
経口	274	391	676	10.7	8.9	8.2
経静脈 or 動注	90	1472	3012	3.5	33.4	36.5
その他	6	23	70	0.23	0.52	0.85
合計	2571	4403	8250	100	100	100



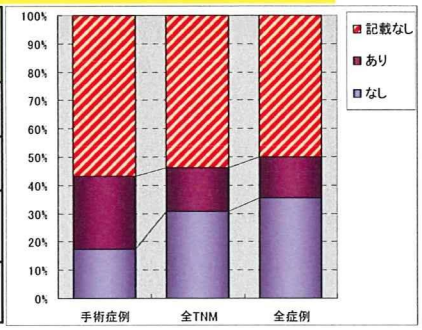
放射線療法の実施状況

	%手術症例	%全TNM	%全症例
なし	42.0	43.2	34.7
あり	1.1	2.9	2.1
記載なし	56.9	53.9	63.2
合計	100	100	100



リハビリテーションの実施状況

	%手術症例	%全TNM	%全症例
なし	17.4	30.8	26.2
あり	25.6	15.3	10.6
記載なし	56.9	53.9	36.8
合計	100	100	100

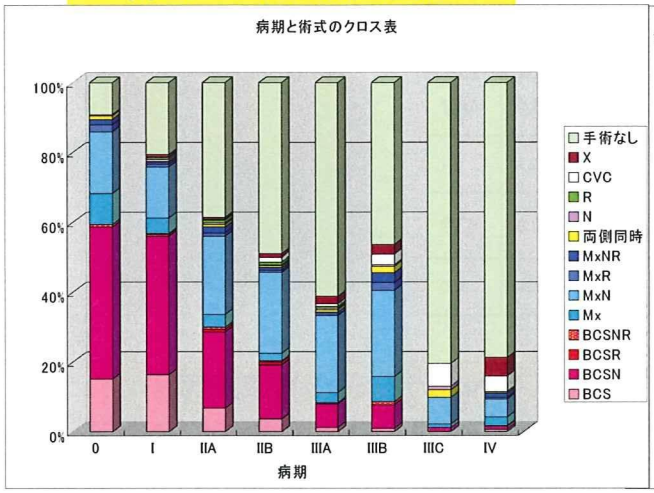


3）クロス集計結果

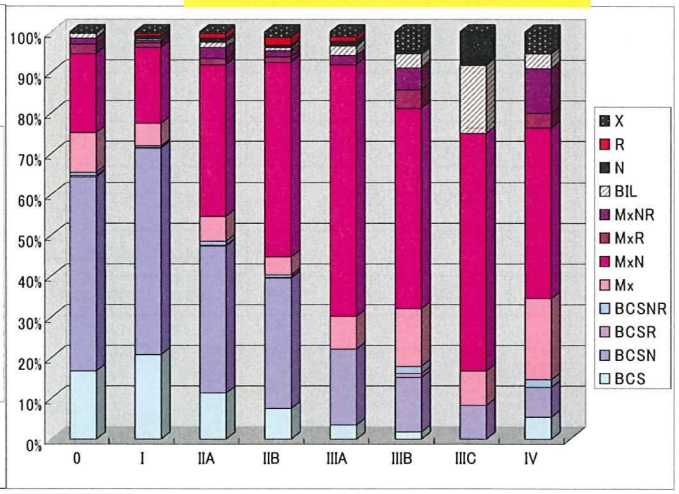
1. 病期別解析
2. 年齢別解析
3. 年次別解析
4. 施設別解析

3)クロス集計結果
1. 病期別解析

術式＜全TNM症例＞



術式＜手術症例＞

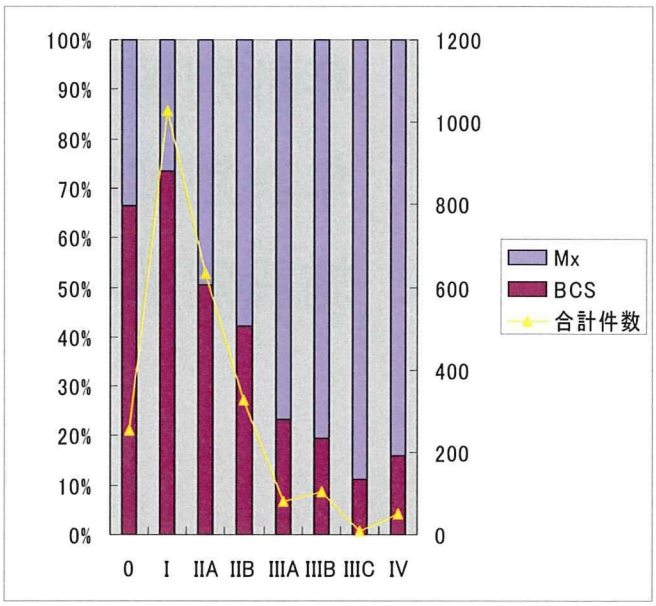


3)クロス集計結果
1.病期別

乳房温存術施行率(=温存率)

○両側、その他の術式を除外

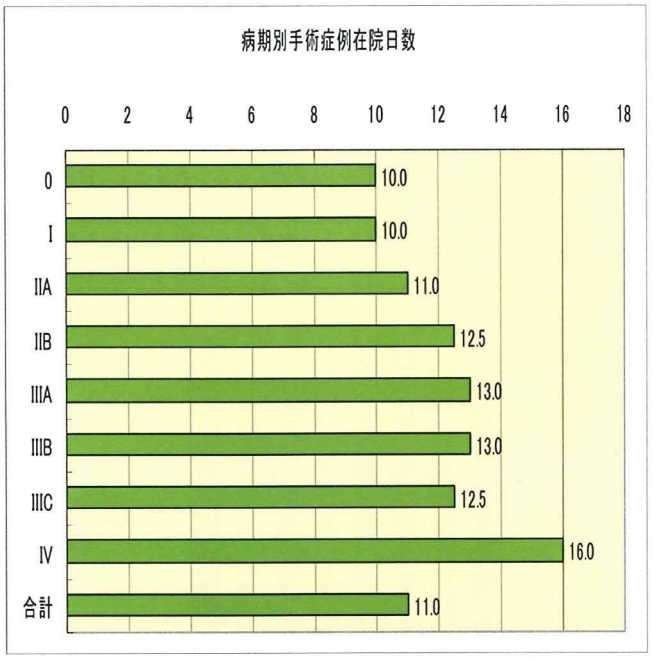
病期	BCS	Mx	合計件数	温存率%
0	169	85	254	66.5
I	755	271	1026	73.6
IIA	319	313	632	50.5
IIB	138	188	326	42.3
IIIA	19	62	81	23.5
IIIB	20	82	102	19.6
IIIC	1	8	9	11.1
IV	8	42	50	16.0
合計	1429	1051	2480	57.6



3)クロス集計結果
1.病期別

在院日数＜手術症例＞

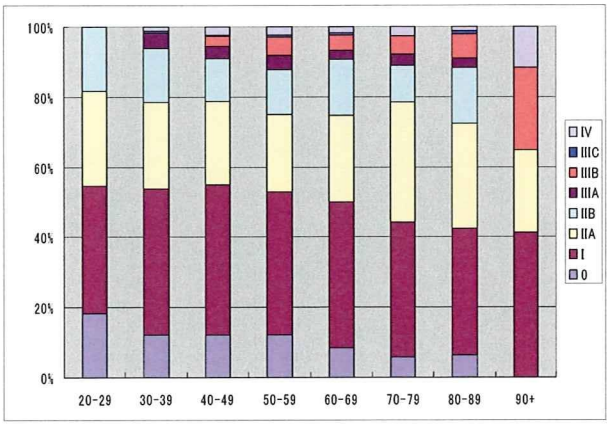
STAGE	中央値	平均値	度数	標準偏差	最小値	最大値
0	10	9.5	258	4.4	1	33
I	10	9.9	1049	4.7	2	55
IIA	11	13.1	657	8.9	2	127
IIB	12.5	14.4	342	7.7	2	66
IIIA	13	16.0	86	12.2	4	85
IIIB	13	17.4	112	15.4	4	121
IIIC	12.5	13.0	12	6.3	6	31
IV	16	29.4	55	49.9	4	332
合計	11	12.2	2571	10.9	1	332



3)クロス集計結果
2.年齢別

病期＜手術症例＞

	0	I	IIA	IIB	IIIA	IIIB	IIIC	IV	合計
20－29	2	4	3	2					11
30－39	20	67	40	25	7		1	2	162
40－49	76	267	149	77	21	18	3	14	625
50－59	82	275	149	85	29	35	3	16	674
60－69	47	234	140	90	14	25	3	10	563
70－79	21	139	125	38	11	19	1	9	363
80－89	10	56	47	25	4	11	1	2	156
90＋		7	4			4		2	17
	258	1049	657	342	86	112	12	55	2571



相関係数

		年齢区分	STAGE_N
年齢区分	Pearson の相関係数	1	.077**
	有意確率（両側）	.	.000
	N	2571	2571
STAGE_N	Pearson の相関係数	.077**	1
	有意確率（両側）	.000	.
	N	2571	2571

**. 相関係数は 1% 水準で有意（両側）です。

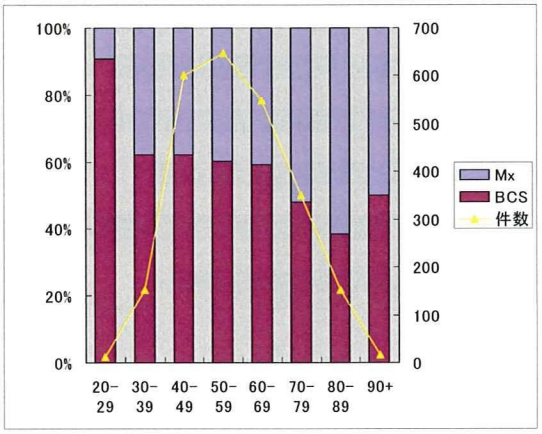
分散分析表

		平方和	自由度	平均平方	F値	有意確率
STAGE_N x 年齢区分	グループ間　（結合）	42.503	7	6.072	2.970	.004
	グループ内	5239.729	2563	2.044		
	合計	5282.232	2570			

3)クロス集計結果
2.年齢別

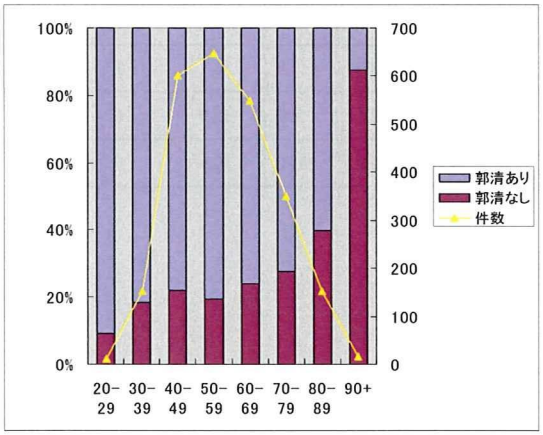
温存率

年齢階層	BCS	Mx	合計	温存率 (%)
20-29	10	1	11	**90.9**
30-39	95	58	153	**62.1**
40-49	374	228	602	**62.1**
50-59	390	257	647	**60.3**
60-69	325	224	549	**59.2**
70-79	168	181	349	**48.1**
80-89	59	94	153	**38.6**
90+	8	8	16	**50.0**
	1429	1051	2480	**57.6**



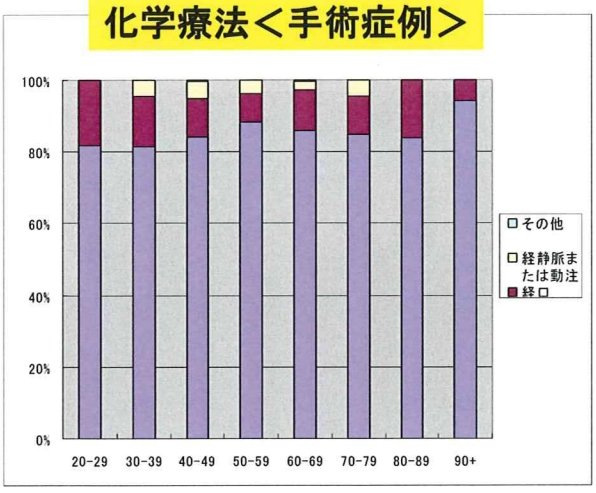
リンパ節郭清率

年齢階層	郭清なし	郭清あり	合計	施行率(%)
20-29	1	10	11	**90.9**
30-39	28	125	153	**81.7**
40-49	133	469	602	**77.9**
50-59	126	521	647	**80.5**
60-69	131	418	549	**76.1**
70-79	96	253	349	**72.9**
80-89	61	92	153	**60.1**
90+	14	2	16	**87.5**
	590	1890	2480	**76.2**

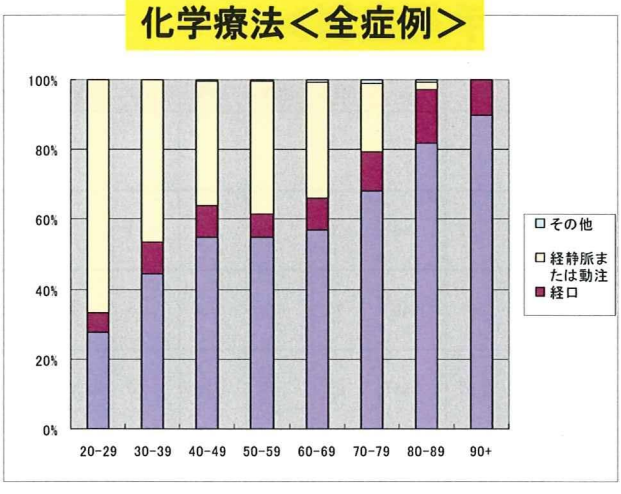


3)クロス集計結果
2.年齢別

化学療法＜手術症例＞



化学療法＜全症例＞

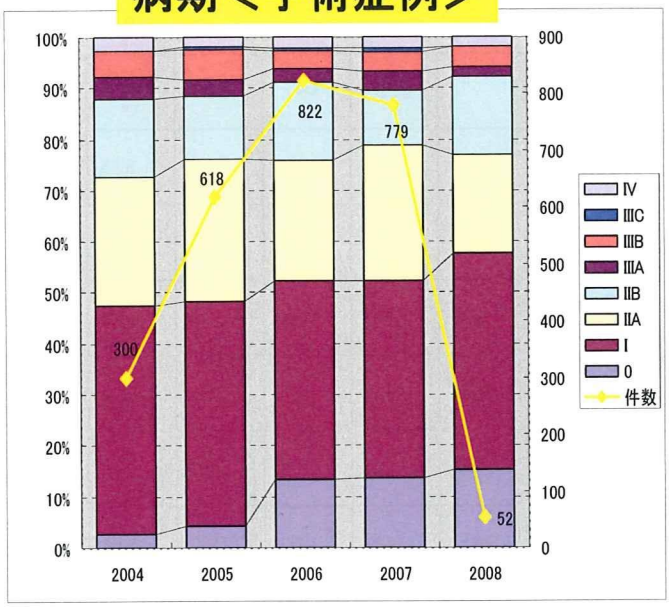


手術症例での化学療法の施行率は、年齢との相関はないが、80歳以上では点滴での化学療法は施行されていない。

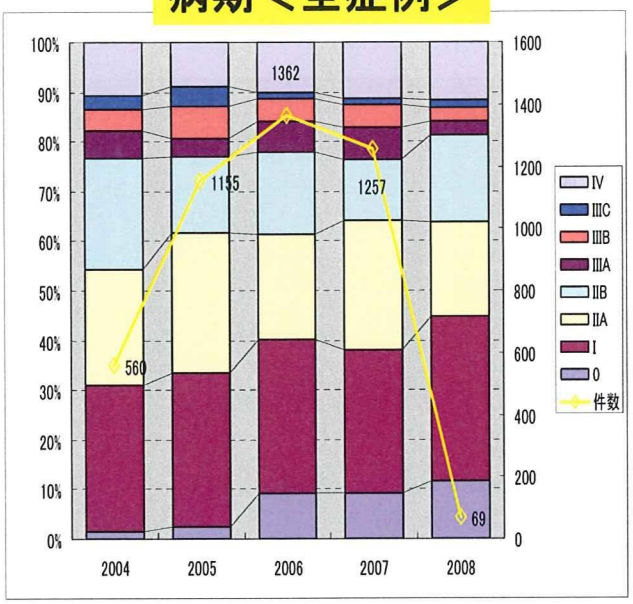
全症例では年齢が上昇に伴い、点滴化学療法の施行率は有意に減少した。80歳以上での化学療法は経口投与が主体となっている。

3)クロス集計結果
3.年次別

病期＜手術症例＞

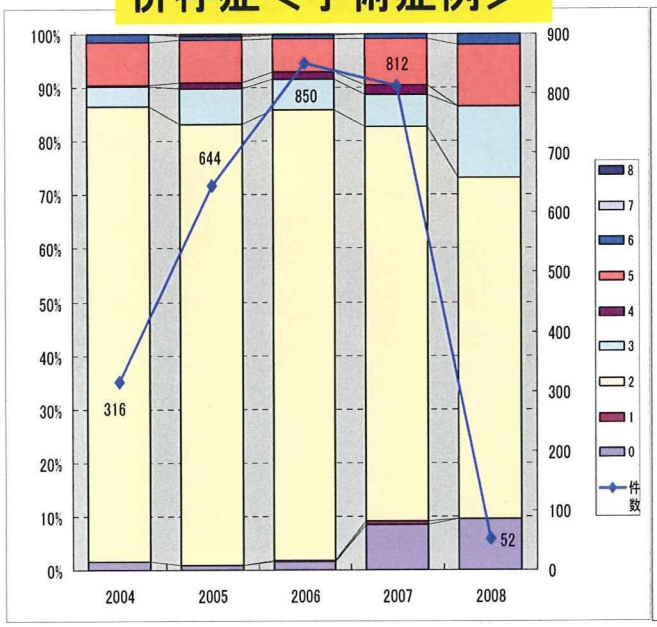


病期＜全症例＞

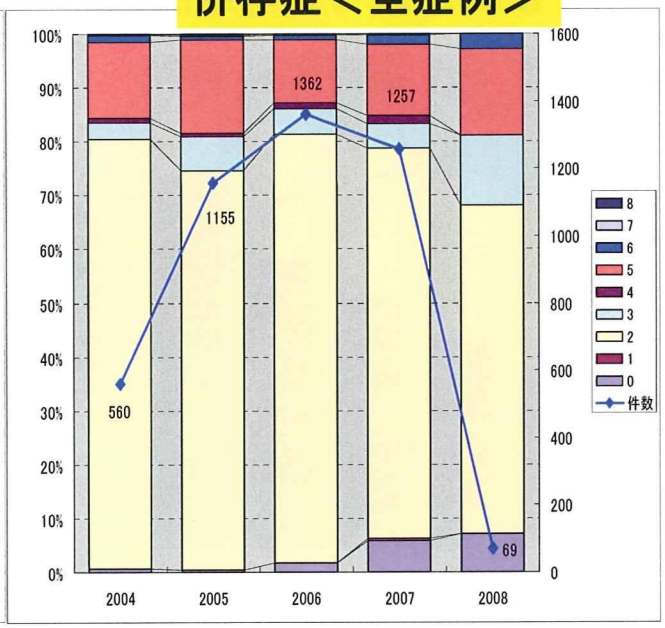


3)クロス集計結果
3.年次別

併存症＜手術症例＞

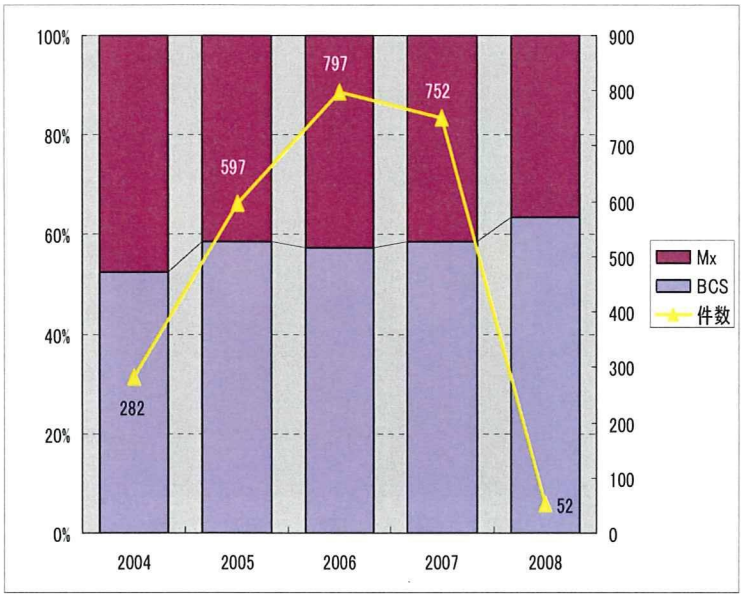


併存症＜全症例＞



3)クロス集計結果
3.年次別

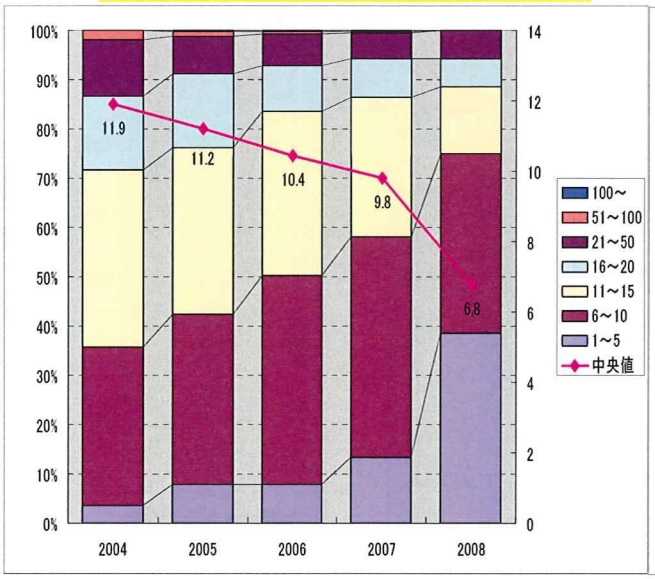
温存率



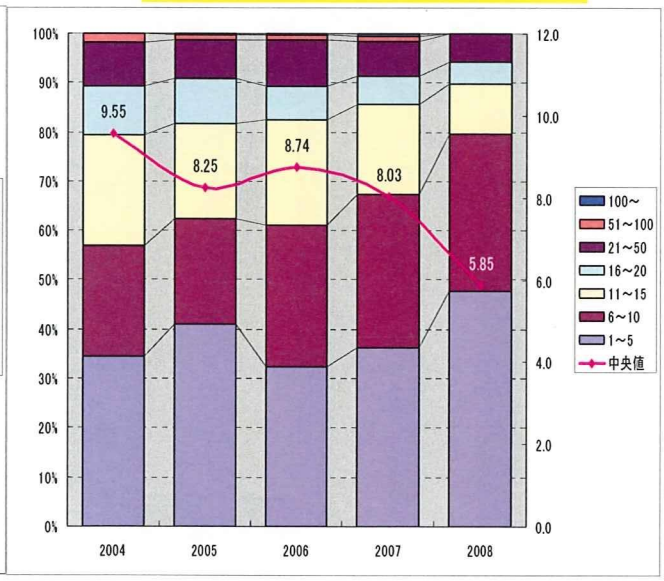
	BCS	Mx	件数	施行率%
2004	148	134	282	52.5
2005	350	247	597	58.6
2006	457	340	797	57.3
2007	441	311	752	58.6
2008	33	19	52	63.5
合計	1429	1051	2480	57.6

3)クロス集計結果
3.年次別

在院日数＜手術症例＞

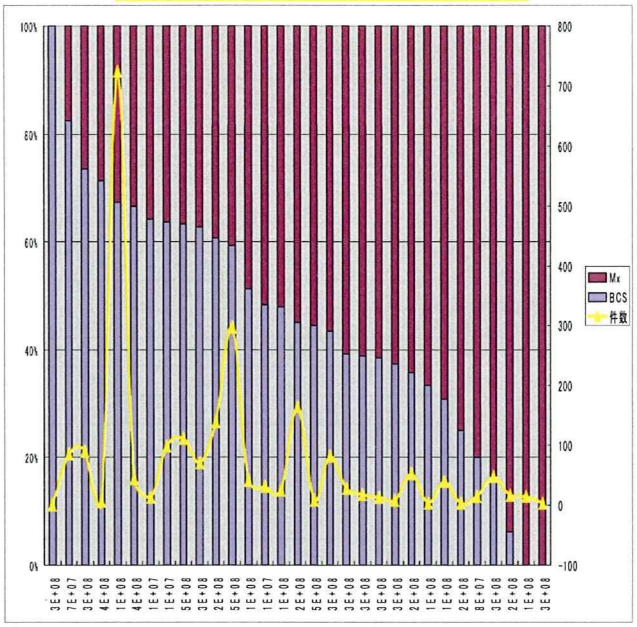


在院日数＜全症例＞

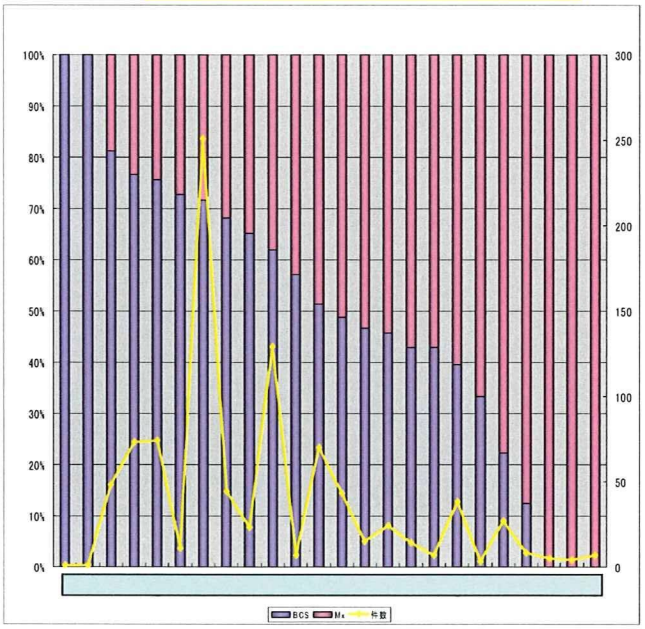


3）クロス集計結果
4.施設別

温存率＜全病期＞



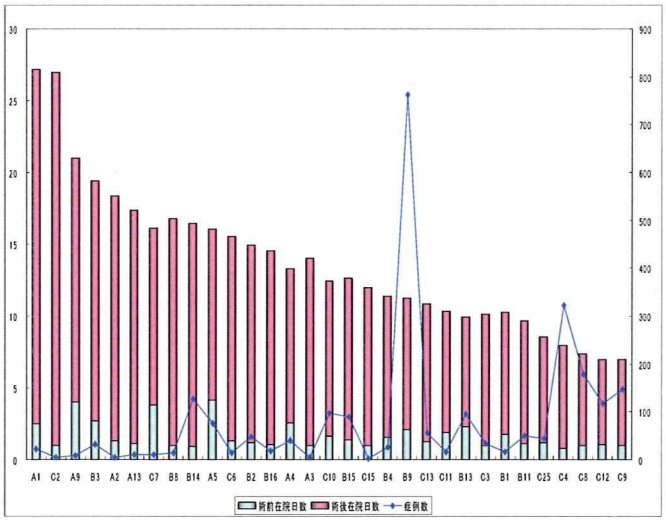
温存率＜Ⅰ・Ⅱ期＞



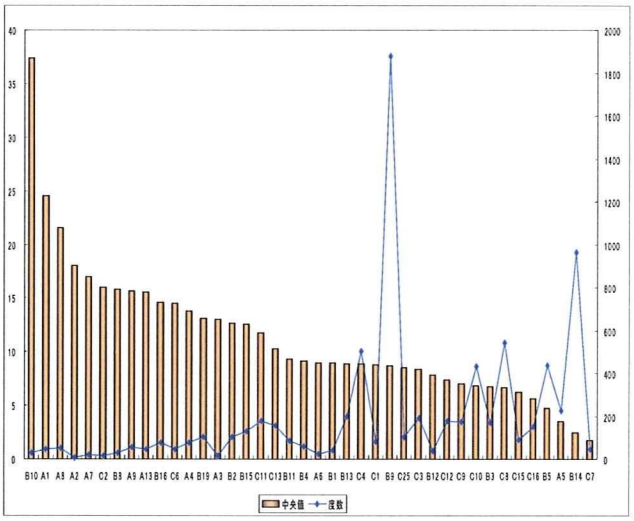
温存率に影響を与えると思われる、専門医の勤務状況や地域性などにも、今後の検討を加えたい。

3）クロス集計結果
4.施設別

在院日数＜手術症例＞



在院日数＜全TNM症例＞



日帰り手術を施行している施設は7件あった。病院別在院日数において（手術や治療の合併症）有害事象または再入院については未解析である。