THE INCIDENCE OF PERIOPERATIVE ADVERSE EVENTS AND RISK FACTORS ON INPATIENT MORBIDITY- A NATIONWIDE CROSS-SECTIONAL OBSERVATIONAL STUDY FROM TAIWAN

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ABSTRACT

BACKGROUND

Research on perioperative adverse events has been challenged by varying definitions, reporting failure, scarce incidence or incomplete data collection. Insights into patient mortality and causes of death might improve surgical safety and quality of care.

The aim of the present study is to analyse the characteristics and factors associated with prognosis (inpatient mortality) of surgery related injuries.

MATERIALS AND METHODS

Data was sourced from the Taiwanese National Health Insurance Research Database for the period of 1997 - 2008; SPSS 18.0 software was used to carry out statistical analysis. Surgery-related injuries were categorised according to ICD-9-CM classifications.

RESULTS

Each year, an average of 797 people are hospitalised in Taiwan due to surgery-related injuries. Males and females accounted for 46.19% and 53.81% of these hospitalisations, respectively. The predominant surgery-related injury events occurred in medical centres (57.89%) and surgery departments (37.71%). The first leading cause of surgery-related injury events was "unintentional cut, puncture, perforation or haemorrhage" (70.59%), but the highest rate of inpatient mortality resulted from "mismatched blood, fluid or substance in transfusion" (4.12%). The average age of male patients (55.97 yrs.) was significantly higher than females (50.99 yrs.). The highest percentage of surgery-related injury events for males was surgery (1.45 per 100,000) and 3.09 times more than those in females that were obstetrics and gynaecology related (0.47 per 100,000). "Unintentional cut, puncture, perforation or haemorrhage" (OR= 6.486), "older patient" (OR +3.8% per increased age) and "younger doctor" (OR +3.3% per increased age) might increase the risk of inpatient mortality.

CONCLUSION

The rate of in-hospital surgery-related injury was 64.55 per 100,000 and exhibited an upward trend. We should make improvement plans for doctors with higher rates of incidences in order to improve the safety of patients.

KEY WORDS

Surgery-Related Injury, Medical-Related Injury, National Health Insurance Research Database.

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BACKGROUND

In 1999, the Institute of Medicine (IOM) in the United States issued a report on the topic of medical errors entitled "To Err is Human." The report indicated that as many as 98,000 cases of medical-error-related deaths could be averted each year in the United States.¹ The revelation sparked a fervent discussion within the academic world followed by leaders of societies and organisations calling for more effort to be focused on preventing medical errors.²⁻⁴

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In 2001, as part of its new hospital accreditation standard, the American Joint Commission on Accreditation of Healthcare Organizations (JCAHO) began requiring institutes and medical personnel under evaluation to disclose cases of medical errors and other unexpected results to patients and family members. Yet a national survey conducted the following year showed that despite the 54% of hospitals that routinely reported their medical errors, only 36% of hospitals had formulated a set of relevant policies to prevent the occurrence of medical errors.⁵

As for other countries, studies by Wilson et al show that the medical error rate in Australia is 16.6%;⁶ Davis et al reveals that the rate of adverse medical events in New Zealand is 11.17%, of which approximately 60% is avertable;⁷ and Vincent et al found the rate of adverse inpatient medical events in the UK to be at 11%.⁸

In Taiwan, there are approximately 2.8 million inpatient cases annually, among which 45% are patients receiving operations or/and procedures. Despite this large number of inpatients, local academic studies exploring the causes of medical-related injuries remain scarce with only two relevant

articles appearing in local journals. One of them is a study analysing data from a single hospital,⁹ while the other though with much more comprehensive national medical data is limited to a short time span of only twelve months.¹⁰ From this point of view, there is a dire need of empirical data to pinpoint high-risk groups in order to prevent medical errors and ensure the safety of patients. Moreover, since the establishment of the Taiwanese Patient Safety Committee by the Department of Health in February 2003, for which it was charged with supervising and carrying out plans and activities involving patient safety.¹¹ No study has yet been undertaken to examine the influence or confirm the efficacy of the organisation with regards to perioperative injuries. This study therefore aims to explore the epidemiological characteristics of inpatient perioperative injuries including the characteristics of patients, hospitals and doctors as well as to analyse the long-term trends and offer practical prognostic information.

MATERIALS AND METHODS

Study Design and Source of Data

The data used in this retrospective descriptive study was retrieved from the National Health Insurance Research Database for the time span of 1997 to 2008. The study is hence categorised as a secondary data analysis. As the Professional Peer Reviewer Committee approved applications for data retrieval and patient's identities were hidden, the study also complies with the Declaration of Helsinki by safely protecting patient's privacy. Information from the National Health Insurance Research Database is an empirical data representative of a national group as a result of health insurance policy's high coverage rate of over 99% of the population in Taiwan.¹² The collection in the database includes information on inpatients, medical institutes and personnel. The database employs the ICD-9-CM coding system, which "in terms of diagnoses" includes one principal diagnosis N-Code and four secondary diagnoses N-Code, and "in terms of cause of injuries" one principal E-Code and one secondary E-Code. All cases used in this study are those of inpatients for which "perioperative injuries" is any one of the five N- and two E-codes. The patient safety indicator, developed by the Agency for Healthcare Research and Quality¹³⁻¹⁵ and ICD-9-CM are used to categorise the cases in question into seven types: "Unintentional cut, puncture, perforation or haemorrhage (998.2, E870)"; "foreign object left in body (998.4, 998.7, E871)"; "failure of sterile precautions (E872)"; "failure in dosage (E873)"; "mechanical failure of instrument or apparatus (E874)"; "contaminated or infected blood or other fluid, drug or biological substance (E875)"; and "mismatched blood, fluid or substance in transfusion (999.6, 999.7, E876)."

Data Analysis

Statistical analysis of perioperative injury trends occurring over the course of a 12-year period was carried out using SPSS 18.0 and Poisson regression. Independent sample t-tests are used to determine the age differences between inpatients of the opposite sex in perioperative injuries. Chi-square test and Fisher's exact test are employed to examine the characteristics of patients, hospitals and doctors in perioperative injury cases. Poisson regression is utilised to identify factors associated with inpatient mortality due to perioperative injuries.

Epidemiological Characteristics

During the 12-year period studied, the number of inpatient perioperative injuries totalled 9,573 at a rate of 64.55 per 100,000. The primary type of cause is "unintentional cut, puncture, perforation or haemorrhage" followed by "foreign object left in body," and then "mismatched blood, fluid or substance in transfusion." A further investigation into causes shows that "unintentional puncture or laceration during a procedure (998.2)" is the leading cause of perioperative injuries accounting for 57.0% followed by "foreign body unintentionally left during a procedure (998.4)" and "unintentional cut, puncture, perforation or haemorrhage during infusion or transfusion (E870.0)" (Table 1).

From 1997 - 2008, a total of 9,206 inpatients were involved in perioperative injuries at a rate of 62.07 per 100,000 with an average age of 53.29. Overall, male patients (62.74 per 100,000) were more prone to perioperative injuries than females (61.52 per 100,000). From an age group point of view, male patients aged 70 - 79 had a markedly higher rate of perioperative injuries than females, while the highest rate in females was the 40 - 49 age group (Table 2).

Both genders shared the same leading causes of injury in order: "unintentional cut, puncture, perforation or haemorrhage," "foreign object left in body" and "mismatched blood, fluid or substance in transfusion." Across all age groups "unintentional cut, puncture, perforation or haemorrhage" appears to be the main cause of perioperative-related injuries and "foreign object left in body" the second with the exception of the under-four age group for which the second leading cause is "mismatched blood, fluid or substance in transfusion" (Table 3).

Among all levels of hospitals, "unintentional cut, puncture, perforation or haemorrhage" is also the main cause of perioperative injury. The second primary cause is "foreign object left in the body" in medical centres and regional hospitals and "failure in dosage" in local hospitals. Department-wise, paediatrics had the highest rate of perioperative injuries (0.68 per 100,000). "Unintentional cut, puncture, perforation or haemorrhage" and "foreign object left in the body" again remained as the top two causes of perioperative injuries across all departments of care with the exception of paediatrics where the second leading cause was "mismatched blood, fluid or substance in transfusion" (Table 3).

Speaking in terms of medical personnel, medical doctors were more prone to causing perioperative injuries than dentists. The two major causes remained "unintentional cut, puncture, perforation or haemorrhage" and "foreign object left in the body." Gender-wise, more male doctors were involved in perioperative injuries than female doctors. "Unintentional cut, puncture, perforation or haemorrhage" remained the top leading cause with differences appearing in the second leading cause of perioperative injury, which for male doctors was "foreign object left in the body," while for female doctors it was a case of "mismatched blood, fluid or substance in transfusion." Age-wise, doctors age in the 60 - 69 group had the highest rate of perioperative injury (0.12 per 100,000) followed by the 50 - 59 age group (0.09 per 100,000). "Unintentional cut, puncture, perforation or haemorrhage" remained the major cause of perioperative injury across all doctor's age groups (Table 3).

Long-Term Trends

The rate of inpatient perioperative injuries was on the decline from 1997 until hitting a floor in 2003, after which the rate began to climb. In total, there was a 26.67% ($p < 0.001$) increase during the 12-year time span. In terms of types of injuries aside from “unintentional cuts, punctures, perforations or haemorrhaging” which increased by 134.38% ($p < 0.001$), “foreign objects left in the body” decreased by 51.66% ($p < 0.001$) and “mismatched blood, fluid or substance in transfusion” similarly decreased by 49.80% ($p=0.001$) (Figure 1).

Male inpatients exhibited a higher rate of perioperative injuries than females from 1997 – 2002. The rate for female patients, however, caught up and then exceeded that of males during 2003 - 2008. The male inpatient perioperative injury rate fell from 1997 until 2004, after which the rate began to increase. The same rate for females shows a steady upward trend with an increased rate of 69.18% ($p < 0.001$).

RESULTS

Factors Associated with Inpatient Mortality

In this study, there were two inpatient perioperative injury prognoses including survival and mortality. When controlling for the characteristics of inpatients (cause of injury, gender, age), hospitals (level of hospitals and departments of care) and doctors (types, gender and age) we find that the prognostic factors include “mismatched blood, fluid or substance in transfusion,” the mortality risk of which is 6.846 times that of “unintentional cut, puncture, perforation or haemorrhage,” $OR= 6.846$, $p= 0.008$), age of patients (risk of mortality increases by 3.8% with the increase of each year, $OR= 1.038$, $p < 0.001$) and age of doctors (risk of mortality decreases by 3.2% with the increase of each year, $OR= 0.968$, $p= 0.013$) (Table 4).

ICD-9-CM	Causes of Perioperative Injuries	N	(%)	Rate ^a
998.2, E870.x	Unintentional cut, puncture, perforation or haemorrhage	6,758	(70.59)	45.57
998.4, 998.7, E871.x	Foreign object left in body	1,338	(13.98)	9.02
999.6, 999.7, E876.x	Mismatched blood, fluid or substance in transfusion	819	(8.56)	5.52
E873.x	Failure in dosage	323	(3.37)	2.18
E874.x	Mechanical failure of instrument or apparatus	194	(2.03)	1.31
E872.x	Failure of sterile precautions	98	(1.02)	0.66
E875.x	Contaminated or infected blood or other fluid, drug or biological substance	43	(0.45)	0.29
	Total	9,573	(100.00)	64.55
First Ten Leading Causes of Perioperative Injuries				
998.2	Unintentional puncture or laceration during a procedure	5,457	(57.00)	36.80
998.4	Foreign body unintentionally left during a procedure	841	(8.79)	5.67
E870.0	Unintentional cut, puncture, perforation or haemorrhage during infusion or transfusion	629	(6.57)	4.24
E876.1	Wrong fluid in infusion	413	(4.31)	2.78
998.7	Acute reaction to foreign substance unintentionally left during a procedure	249	(2.60)	1.68
E871.9	Foreign object left in body during unspecified procedure	169	(1.77)	1.14
E870.8	Unintentional cut, puncture, perforation or haemorrhage during other medical care	158	(1.65)	1.07
E870.4	Unintentional cut, puncture, perforation or haemorrhage during endoscopic examination	106	(1.11)	0.71
E870.7	Unintentional cut, puncture, perforation or haemorrhage during administration of enema	103	(1.08)	0.69
E870.5	Unintentional cut, puncture, perforation or haemorrhage during aspiration of fluid or tissue, puncture and catheterisation (any, except heart catheterisation)	102	(1.07)	0.69

Table 1. Inpatient Perioperative Injury Cases and Rates in Taiwan, 1997 - 2008

^a (Number of inpatient perioperative injury cases) ÷ (Number of inpatients receiving surgeries) × 100,000

	Total			Males			Females			P-value ^b
Ages (yrs.)	53.29 ± 20.15			55.97 ± 21.66			50.99 ± 18.44			< 0.001***
Mean ± SD										
Age Groups	N	(%)	Rate ^a	N	(%)	Rate ^a	N	(%)	Rate ^a	
<1 yr.	122	(1.33)	46.15	65	(1.53)	44.28	57	(1.15)	48.48	0.856
1-4 yrs.	97	(1.05)	35.07	62	(1.46)	36.99	35	(0.71)	32.13	0.743
5-9 yrs.	81	(0.88)	36.19	49	(1.15)	36.07	32	(0.65)	36.38	0.821
10-14 yrs.	58	(0.63)	28.67	29	(0.68)	22.48	29	(0.59)	39.57	0.966
15-19 yrs.	192	(2.09)	35.78	122	(2.87)	42.92	70	(1.41)	27.73	0.519
20-24 yrs.	242	(2.63)	22.46	125	(2.94)	36.16	117	(2.36)	15.99	0.779
25-29 yrs.	351	(3.81)	22.18	139	(3.27)	42.26	212	(4.28)	16.91	0.632
30-34 yrs.	473	(5.14)	33.54	158	(3.72)	44.80	315	(6.36)	29.79	0.234
35-39 yrs.	652	(7.08)	65.82	220	(5.17)	53.57	432	(8.72)	74.50	0.104
40-44 yrs.	904	(9.82)	97.13	252	(5.93)	54.12	652	(13.16)	140.19	0.002**
45-49 yrs.	902	(9.80)	94.45	295	(6.94)	59.41	607	(12.26)	132.39	0.015*

50-54 yrs.	731	(7.94)	81.11	287	(6.75)	59.61	444	(8.96)	105.76		0.285
55-59 yrs.	628	(6.82)	75.89	298	(7.01)	66.45	330	(6.66)	87.07		0.862
60-64 yrs.	710	(7.71)	83.89	357	(8.39)	78.63	353	(7.13)	89.97		0.531
65-69 yrs.	795	(8.64)	82.54	408	(9.59)	77.70	387	(7.81)	88.34		0.374
70-74 yrs.	862	(9.36)	85.17	530	(12.46)	91.11	332	(6.70)	77.13		0.007**
75-79 yrs.	711	(7.72)	80.13	426	(10.02)	81.40	285	(5.75)	78.30		0.043*
80-84 yrs.	427	(4.64)	74.77	262	(6.16)	81.78	165	(3.33)	65.80		0.194
85-89 yrs.	184	(2.00)	68.34	112	(2.63)	82.10	72	(1.45)	54.20		0.591
90-94 yrs.	75	(0.81)	89.12	50	(1.18)	132.49	25	(0.50)	53.86		0.114
95-99 yrs.	9	(0.10)	57.10	7	(0.16)	115.76	2	(0.04)	20.59		0.967
Total	9,206	(100.00)	62.07	4,253	(100.00)	62.74	4,953	(100.00)	61.52		< 0.001***

Table 2. Perioperative Injury Rates of Patients of different Sex and Age in Taiwan, 1997 - 2008

^a (Number of inpatient perioperative injury cases) ÷ (Number of inpatients receiving surgeries) × 100,000

^b Independent sample t-test: *p < 0.05, **p < 0.01, ***p < 0.001

Causes of Perioperative Injuries	Total		Unintentional Cut, Puncture, Perforation or Haemorrhage		Foreign Object Left in Body		Failure of Sterile Precautions		Failure in Dosage		Mechanical Failure of Instrument or Apparatus		Contaminated or Infected Blood or Other Fluid, Drug or Biological Substance		Mismatched Blood, Fluid, or Substance in Transfusion		P-value
	N	Rate ^a	N	Rate ^a	N	Rate ^a	N	Rate ^a	N	Rate ^a	N	Rate ^a	N	Rate ^a	N	Rate ^a	
Characteristic of inpatient																	
Sex																	<0.001 ^b
Male	4,253	62.74	2,800	41.30	634	9.35	55	0.81	203	2.99	101	1.49	28	0.41	432	6.37	
Female	4,953	61.52	3,720	46.20	629	7.81	42	0.52	115	1.43	77	0.96	15	0.19	355	4.41	
Age groups																	<0.001 ^b
0-4 yrs. child	219	40.49	111	20.52	30	5.55	4	0.74	10	1.85	8	1.48	5	0.92	51	9.43	
5-14 yrs. early youth	139	32.62	62	14.55	33	7.75	5	1.17	10	2.35	5	1.17	2	0.47	22	5.16	
15-24 yrs. youth	434	26.89	198	12.27	96	5.95	7	0.43	60	3.72	7	0.43	5	0.31	61	3.78	
25-44 yrs. prime age	2,380	48.43	1,659	33.76	382	7.77	22	0.45	108	2.20	32	0.65	11	0.22	166	3.38	
45-64 yrs. middle age	2,971	84.16	2,200	62.32	404	11.44	24	0.68	83	2.35	44	1.25	12	0.34	204	5.78	
≥65 yrs. elderly	3,063	80.54	2,290	60.22	318	8.36	35	0.92	47	1.24	82	2.16	8	0.21	283	7.44	

Table 3. Inpatient Perioperative Injury Cases and Rates among different Characteristics of Patients, Hospitals and Doctors in Taiwan, 1997 - 2008

^a (Number of inpatient perioperative injury cases) ÷ (Number of inpatients receiving surgeries) × 100,000

^b Chi-square test.

Causes of Perioperative Injuries	Total		Unintentional Cut, Puncture, Perforation or Haemorrhage		Foreign Object Left in Body		Failure of Sterile Precautions		Failure in Dosage		Mechanical Failure of Instrument or Apparatus		Contaminated or Infected Blood or Other Fluid, Drug or Biological Substance		Mismatched Blood, Fluid or Substance in Transfusion		P-value
	N	Rate ^a	N	Rate ^a	N	Rate ^a	N	Rate ^a	N	Rate ^a	N	Rate ^a	N	Rate ^a	N	Rate ^a	
Characteristic of Hospital																	
Level of Care																	<0.001 ^b
Medical Centre	5,542	4.98	4,480	4.02	679	0.61	24	0.02	45	0.04	68	0.06	2	<0.01	244	0.22	
Regional Hospital	3,128	0.53	1,938	0.33	508	0.09	50	0.01	44	0.01	103	0.02	19	<0.01	466	0.08	
Local Hospital	903	0.12	340	0.04	151	0.02	24	<0.01	234	0.03	23	<0.01	22	<0.01	109	0.01	
Department of Care																	<0.001 ^c
Internal Medicine	1,425	0.31	929	0.20	242	0.05	25	0.01	27	0.01	58	0.01	7	<0.01	137	0.03	
Surgery	3,610	0.45	2,375	0.30	608	0.08	44	0.01	249	0.03	71	0.01	19	<0.01	244	0.03	
Obstetrics and Gynaecology	1,958	0.63	1,785	0.58	109	0.04	1	<0.01	2	<0.01	8	<0.01	0	0	53	0.02	
Paediatrics	257	0.68	130	0.34	30	0.08	5	0.01	2	0.01	9	0.02	7	0.02	74	0.19	
Other Department	2,323	0.29	1,539	0.19	349	0.04	23	<0.01	43	0.01	48	0.01	10	<0.01	311	0.04	
Table 3. Inpatient Perioperative Injury Cases and Rates among different Characteristics of Patients, Hospitals and Doctors in Taiwan, 1997 - 2008 (Continued)																	

Table 3. Inpatient Perioperative Injury Cases and Rates among different Characteristics of Patients, Hospitals and Doctors in Taiwan, 1997 - 2008 (Continued)

^a (Number of inpatient perioperative injury cases) ÷ (Number of inpatients receiving surgeries) × 100,000

^b Chi-square test.

^c Fisher's exact test.

Causes of Perioperative Injuries	Total		Unintentional Cut, Puncture, Perforation or Haemorrhage		Foreign Object Left in Body		Failure of Sterile Precautions		Failure in Dosage		Mechanical Failure of Instrument or Apparatus		Contaminated or Infected Blood or Other Fluid, Drug or Biological Substance		Mismatched Blood, Fluid or Substance in Transfusion		P-value
	N	Rate ^a	N	Rate ^a	N	Rate ^a	N	Rate ^a	N	Rate ^a	N	Rate ^a	N	Rate ^a	N	Rate ^a	
Characteristic of Medical Personnel																	
Type of medical personnel																	<0.001 ^b
Doctor	9,509	0.05	6,734	0.04	1,305	0.01	98	<0.01	323	<0.01	194	<0.01	194	<0.01	819	<0.01	
Dentist	64	<0.01	33	<0.01	31	<0.01	0	0	0	0	0	0	0	0	0	0	
Sex																	<0.001 ^c
Male	9,099	0.03	6,417	0.02	1,295	<0.01	94	<0.01	320	<0.01	183	<0.01	37	<0.01	753	<0.01	
Female	474	<0.01	341	<0.01	43	<0.01	4	<0.01	3	<0.01	11	<0.01	6	<0.01	66	<0.01	
Age Groups																	<0.001 ^b
20-29 yrs.	10	<0.01	6	<0.01	2	<0.01	0	0	0	0	0	0	0	0	2	<0.01	
30-39 yrs.	3,271	0.04	2,264	0.03	479	0.01	35	<0.01	112	<0.01	77	<0.01	17	<0.01	287	<0.01	
40-49 yrs.	4,259	0.07	2,945	0.05	611	0.01	49	<0.01	133	<0.01	93	<0.01	17	<0.01	411	0.01	
50-59 yrs.	1,738	0.09	1,317	0.07	223	0.01	10	<0.01	58	<0.01	20	<0.01	4	<0.01	106	0.01	
60-69 yrs.	267	0.12	218	0.09	22	0.01	3	<0.01	9	<0.01	4	<0.01	1	<0.01	10	<0.01	
70-79 yrs.	28	0.04	8	0.01	1	<0.01	1	<0.01	11	0.02	0	0	4	0.01	3	<0.01	
Table 3. Inpatient Perioperative Injury Cases and Rates among different Characteristics of Patients, Hospitals and Doctors in Taiwan, 1997 - 2008 (Continued)																	

Table 3. Inpatient Perioperative Injury Cases and Rates among different Characteristics of Patients, Hospitals and Doctors in Taiwan, 1997 - 2008 (Continued)

^a (Number of inpatient perioperative injury cases) ÷ (Number of inpatients receiving surgeries) × 100,000

^b Fisher's exact test.

^c Chi-square test.

Variables	B	Adjusted OR	95% CI	P-value
Characteristic of Patient				
Causes of perioperative injuries				
Unintentional cut, puncture, perforation or haemorrhage		Reference		
Foreign object left in body	-0.167	0.846	0.211-3.394	0.813
Failure of sterile precautions	-0.413	0.662	0.352-1.246	0.201
Failure in dosage	-1.327	0.265	0.035-2.039	0.302
Mechanical failure of instrument or apparatus	0.289	1.336	0.660-2.704	0.421
Contaminated or infected blood or other fluid, drug or biological substance	<i>No mortality cases</i>			
Mismatched blood, fluid or substance in transfusion	1.167	6.846	5.211-8.393	0.008**
Sex				
Male	0.302	1.353	0.987-1.816	0.064
Female		Reference		
Ages	0.038	1.038	1.027-1.050	<0.001***
Characteristic of Hospital				
Level of Care				
Medical Centre	0.917	2.501	0.996-5.537	0.052
Regional Hospital	0.723	2.060	0.920-4.610	0.079
Local Hospital		Reference		
Department of Care				
Internal Medicine	1.171	3.326	0.992-5.096	0.051
Surgery	1.038	2.825	0.822-4.380	0.057
Obstetrics and Gynaecology	-0.568	0.567	0.221-1.453	0.237
Paediatrics	1.840	6.295	0.925-29.913	0.121
Other Departments		Reference		
Characteristic of Medical Personnel				
Type of medical personnel				
Doctor	-0.528	0.590	0.081-4.308	0.603
Dentist		Reference		
Sex				
Male	0.063	1.065	0.528-2.151	0.860
Female		Reference		
Ages	-0.033	0.968	0.948-0.987	0.013*

Table 4. Factors influencing Inpatient Deaths in Taiwan due to Perioperative Injuries, 1997 - 2008^a

^a Poisson regression and dependent variable was prognosis (Survive: n= 9, 005, rate= 60.72 per 100,000; mortality: n= 201, rate=1.36 per 100,000); * p < 0.05, ** p < 0.01, *** p < 0.001

Figure 1. Trend of Inpatient Perioperative Injuries in Taiwan, 1997 - 2008

DISCUSSION

Long-Term Trends

The analysis shows that inpatient perioperative injury rates dropped from 1997 to their lowest point in 2003 and subsequently began to ascend thereafter. This phenomenon may be explained by the establishment of the Taiwanese Patient-Safety Reporting System (TPR) by the Department of Health in 2003 to encourage hospitals and medical institutes to report incidents of medical injuries. The increase in perioperative injury rate may be closely related to the increased number of reporting hospitals.¹⁶ A Harvard Medical Practice Study shows that the rate of inpatient medical adverse events is 3.7%.¹⁷ Moreover, studies by American scholars Thomas et al show that 39.5% of medical adverse events are in association with surgeries.¹⁸ With a total of 14,830,710 inpatients in Taiwan during 1997 - 2008, an estimated number of 216,751 cases of medical injuries should occur if calculated by the rate mentioned above ($14,830,710 \times 3.7\% \times 39.5\%$). Yet the National Health Insurance Research Database offers only 9,206 documented cases, far less than the estimated figure. One of the possible reasons may be that most hospitals consider perioperative injuries a sensitive issue and avoid bringing them to light. Additionally, by the end of 2008, only 33% of hospitals in Taiwan took part in the Taiwan Patient-Safety Reporting System, the participation in which was not made mandatory but merely discretionary. The difference between estimates and actual cases may likely come from hospitals leaving out perioperative injury events when reporting to authorities.

Epidemiological Characteristics

“Unintentional cut, puncture, perforation or haemorrhage,” “foreign object left in the body” and “mismatched blood, fluid or substance in transfusion” were the leading causes of inpatient perioperative injuries. There are echoing reports supporting that errors in transfusion or medication, foreign objects left in the body, wrong-site surgeries and wrong-

patient surgeries are common causes of perioperative injuries.¹⁹⁻²⁰ This study further divides the five major departments into specific departments of care and finds that most perioperative injuries occur in Obstetrics and Gynaecology (Ob-Gyn), accounting for 20.45% (data not presented). Some overseas studies have yielded corresponding results.¹⁷ With the majority Ob-Gyn patients being females, this may explain why the number of inpatients perioperative injury cases is higher in females than in males.

In terms of level of hospitals, medical centres had the highest rate of surgery injuries (4.98 per 100,000)- that is 9.4 and 41.5 times as many as those of regional and local hospitals. This means that number of perioperative injuries increases with the level of hospitals. This can be attributed to the inadequate equipment at lower-level hospitals, which leads to the transfer of patients with more serious and complex conditions to medical centres for surgery.²¹ As a result, the perioperative injury rate at medical centres appears much higher than other grades of hospitals.

With regard to departments of care, the major cause of perioperative injury in Ob-Gyn is “unintentional cut, puncture, perforation or haemorrhage.” Taking a closer look at the OP-code of such patients, we find that total abdominal hysterectomy (OP68.4) takes up 26.86%, laparoscopically assisted vaginal hysterectomy (OP68.51) accounts for 21.75% and radical abdominal hysterectomy (OP68.6) occupies 5.52%. That is to say there is an apparent association between surgeries on the uterus and perioperative injuries. The diagnoses (N-Code) are mostly leiomyoma of uterus (218.9) accounting for 15.73%, endometriosis of uterus (617.0) taking up 12.40% and intramural leiomyoma of uterus (218.1) occupying 8.78%. In the Department of Surgery, “unintentional cut, puncture, perforation or haemorrhage” is also the leading cause. The OP-code of these patients includes “cholecystectomy”

(OP51.22) accounting for 4.16%, “excisional debridement of wound, infection or burn” (OP86.22) taking up 3.17% and “laparoscopic cholecystectomy” (OP1.23) occupying 2.19%. This highlights the correlation between complex surgeries and the rate of injury. Complex surgeries are defined as surgeries involving general anaesthesia, cutting of deep skin tissues, microsurgery, organ transplants, vital organs (the brain, heart, lung and/or spinal cord) and equipment (such as a heart-lung machine) upon which the patient’s life is dependent. The diagnoses (N-Codes) are “primarily malignant neoplasm of rectum” (154.1) accounting for 10.01%, “calculus of gallbladder with acute cholecystitis” without mention of obstruction (574.00), occupying 6.68% and calculus of gallbladder with other cholecystitis without mention of obstruction (574.10) taking up 2.55%. It is indicated in some studies that in Taiwan, the departments of care most likely to be involved in civil lawsuits are Emergency Medicine, Department of Surgery (Neurosurgery and Plastic Surgery), Ob-Gyn, Orthopaedics and Ophthalmology.²² This study also has corresponding result that the Department of Surgery has a slightly higher rate of perioperative injury and that the number of perioperative injury cases is higher in Ob-Gyn and the Department of Surgery.

Factors associated with Inpatient Mortality

Prognostic factors of perioperative injuries are mismatched blood, fluid or substance in transfusion, age of patient and age of doctor. In terms of mismatched blood, fluid or substance in transfusion, there are various blood group systems such as MNSsU, Lewis, Duffy, Kidd and other types totalling over 30 kinds besides the common A, B, O and RH. Even the most common blood types of A, B, O and RH are further divided into various subtypes (such as A₁, A₂, A₃, A_x, A_m, A_{el}, B₃, B_x, B_m, B_{el} and RH(D)) and Bombay.²³⁻²⁴ Mistransfusion can cause urticaria, skin hives, tachycardia, dyspnoea, low), dropping of blood pressure, bleeding with unknown cause and Disseminated Intravascular Coagulation (DIC). Failure to treat on time can lead to death.²⁵ This explains the higher risk of death resulting from “mismatched blood, fluid or substance in transfusion.” In terms of patient’s age, literature in the past has pointed out that the degeneration of physiological and bodily functions makes the seniors much more susceptible to damages that may otherwise cause no or less damage to younger patients.²⁶⁻²⁷ With regard to age of doctor, as information regarding the seniority of doctors is unavailable at the National Health Insurance Research Database, this study has substituted such factor with the age of doctors. As previous literature has indicated, senior doctors are more experienced with better skills at surgeries and are thus less likely to misdiagnose or cause medical injuries. Younger doctors, on the other hand, lack hands-on experiences²⁸ and are more prone to perioperative injuries and hence increase the risk of mortality for inpatients.

Implications for Research, Practice and Policy

When taking a look at the previous body of literature, we find that medical injuries have varying definitions in different studies.²⁹⁻³⁰ Medical injuries include nosocomial infection, Adverse Drug Reaction (ADR) and perioperative injuries. This study focuses primarily on perioperative injuries. It is recommended for future studies to explore medical injuries

in nosocomial infection (998.5, 999.3) and ADR (E930 - E949) using the National Health Insurance Research Database in Taiwan.

This study also finds that the number of samples associated with perioperative injuries in the National Health Insurance Research Database is far less than the estimated number. In addition, only 33% of hospitals participated in the Taiwan Patient-Safety Reporting System by the end of 2008. It is therefore important to encourage more hospitals and medical institutes to take part in the report system and require medical personnel by law to duly report medical injuries. Moreover, it is advised to reduce perioperative injuries and increase medical safety by reinforcing medical ethics, improving medical technology and performing surgeries strictly by standard protocols.

With past studies sampling only from a single hospital⁹ or during a single year,¹⁰ this study is the pioneering study to employ data from the National Health Insurance Research Database to discuss inpatient perioperative injuries on a national scale. Despite the possible underestimation in the result, the study provides valuable empirical data on perioperative injuries representative of the nation, which can serve as an important reference for the drafting of comprehensive patient safety plans.

Limitations

In Taiwan, surgical teams rather than individual doctors usually carry out surgeries. While senior doctors perform some surgeries, it is possible that some surgeries are partly carried out by assistant doctors. As there is no way to know for sure if all perioperative injuries are indeed caused by the recorded senior doctors, inaccuracies may occur.

CONCLUSION

In Taiwan, during 1997 to 2008, the major causes of perioperative injuries were-

“Unintentional cut, puncture, perforation or haemorrhage,” and “mismatched blood, fluid or substance in transfusion.” Senior patients and younger doctors, with whom there is an increased risk of mortality.

During the twelve-year period, the total rate of perioperative injuries was 64.55 per 100,000 with a 26.67% rate of increase.

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