

2018

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Sciedu Press

Tieteelliset aikakauslehtiartikkelit

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<http://dx.doi.org/10.5430/jha.v7n6p30>

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ORIGINAL ARTICLE

Financial cost of elective day of surgery cancellations

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Received: June 16, 2018

Accepted: November 13, 2018

Online Published: November 19, 2018

DOI: 10.5430/jha.v7n6p30

URL: <https://doi.org/10.5430/jha.v7n6p30>

ABSTRACT

Operative care is one of the major areas of healthcare services as over 310 million surgeries are conducted yearly. Surgery cancellations is a widely used indicator when evaluating the quality of preoperative care. Cancellations cause financial loss for organizations, however there is only limited research about the costs. The aim of this study was to evaluate the cost of elective day of surgery (DOS) cancellations in 13 operative specialties at a university hospital in Finland between September 1, 2015 and May 31, 2016 after a structured preoperative protocol was implemented to practice and a cancellation rate of 4.7% was recognized. Procedure prices conducted the data for the research and were collected from the hospital's invoicing system. Financial loss and savings of cancellations were calculated from the total cost of procedures. As a result the total cost of DOS cancellations during the nine-month time period was 953,374.27 euros and mean loss of a single cancelled operation was 2,459.91 euros. The total of material savings for the hospital were 106,917.33 euros. As a conclusion, DOS cancellations cause unnecessary wastage, and financial aspects should be followed and evaluated systematically by setting goals and providing continuing developments.

Key Words: Economics, Finance, Waste, Cost, Surgery cancellation, Operative care

1. INTRODUCTION

The hospital sector is the largest component of health care spending in the Organization for Economic Co-operation and Development (OECD) and European Union (EU) countries.^[1] Surgery is one of the major areas of healthcare services. Globally, approximately 312.9 million operations are conducted every year.^[2] According to study results of a cross-sectional and longitudinal study conducted in USA the mean cost of one minute of operation room (OR) time is approximately 36-37 US dollars.^[3] Day of surgery (DOS) cancellations are a recognized problem in perioperative care and one of the nursing-sensitive quality indicators in perioperative care.^[4] A single cancellation causes personal and

economic harm for the patient^[5] and resource related waste for organizations.^[6]

Cancellation occurrences vary widely across health care organizations; the highest rate may be more than 700 times higher than the lowest.^[7] Studies published since 2016 report variable elective DOS cancellation rates of 4.4% (tertiary care teaching hospital in Lebanon),^[8] 4.7% (university hospital in Finland),^[9] 8.8% (pediatric ambulatory surgery center in the US),^[10] 26% (regional hospital in Oman),^[11] and 44.5% (general hospital in South Africa).^[12] Similar to cancellation rates, costs of surgical procedures vary across countries and are related to the type of procedure.^[7, 13, 14]

The development of surgical processes is encouraged as a

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way to reduce unnecessary costs.^[1] Practices for enhancing high-quality, safe and cost-effective perioperative processes have been implemented worldwide in recent years. Preoperative cost effectiveness requires optimization of the surgical process and patient specific management.^[15] A patient-centered approach to the reform of preoperative care has led to positive change, decreasing DOS cancellations and average length of stay and increasing patient volume, OR use, the number of patients admitted on the DOS, and patient satisfaction.^[9, 16–23, 23–28, 28]

“Cost” is defined as the amount of hospital expenditures for resources used to deliver care.^[13] Operational costs in the OR depend on start times, turnover times, cancellation rates, supplies, equipment, and staffing.^[30] The development and remodeling of surgical processes to achieve cost effectiveness have been encouraged. Researchers have been careful in measuring the economic impact of these changes, although evaluation based on cost is recommended.^[16, 26]

The aim of this study is to measure the financial cost of DOS cancellations. Data are drawn from a university hospital’s 13 operative specialties after the implementation of an evidence based, structured preoperative protocol.^[9, 31]

Literature review

A literature review of costs of DOS cancellations was conducted in PubMed and CINAHL in 2010–2017 using keywords such as “surgery”, “operation”, “cancellation”, “cost”, and “evaluation”. Articles included in the literature review are presented in Table 1. A total of six academic journal articles reported on costs of cancellations. Four articles were published in the United States,^[32–35] one in Brazil,^[36] and one in South Africa.^[12] In addition, an editorial article published in the United States discussed OR time costs and suggested using an average cost of 15 to 20 US dollars per OR minute for a basic surgical procedure, excluding physician costs.^[13]

The earliest cost evaluation was based on data collected in 2004,^[36] and the latest used data from 2014.^[12, 35] Calculations of surgery cancellation costs were based on several different indicators: wasted OR time,^[32, 33] hospital and physician data, such as the average surgeon fee for the planned procedure, including the average hospital facility fee per minute based on planned surgical time,^[34] an organization’s annual statistics on what were considered unnecessary inpatient days,^[12] and nurse-led preoperative assessments.^[35] Costs of cancellations were measured after preparation of the operating room and during the operation, costs were divided into four parts: materials, fees, medication, and human resources.^[36]

The average cost of a cancelled operation in the US is approximately 5,000 to 8,000 US dollars.^[33–35] In South Africa, the cost is approximately 2,000 US dollars,^[12] and in Brazil, it is 30 US dollars.^[36] Wasted OR suite minutes cost 10 to 20 US dollars per minute on average in the US.^[13, 32] Research on the financial cost of DOS cancellations is limited, and more evidence-based studies are needed to promote understanding of the costs of cancelled operations.

2. METHODS

2.1 Aims

The aim of this study is to measure the financial cost of DOS cancellations using procedure prices for a university hospital’s 13 operative specialties during a nine-month period.

2.2 Research site

The research was conducted at a university teaching hospital in Finland. The hospital is responsible for specialized medical care for nearly a million inhabitants and provides care in all surgical specialties. The hospital has 26 operating theaters where approximately 22,000 procedures are conducted yearly. OR staff work in elective surgery setting mainly Monday to Friday between 7:00 a.m.–3:30 p.m.

The hospital put a structured, evidence based preoperative protocol into clinical practice in all 13 operative specialties (gastrointestinal surgery; pediatrics; hand surgery; cardiac and thoracic surgery; urology; vascular surgery; neurosurgery; gynecology; ophthalmology; ear, nose, and throat surgery; dental surgery; orthopedics; and plastic surgery) between the years 2014 and 2015. In May 2015, all intraoperative care and recovery areas were gathered and moved to a single location while a new hospital building was being opened.

The new protocol was coordinated by preoperative nurses. Their main responsibility was to meet patients’ needs individually, prepare patients for surgery, and cooperate with other professionals in the patients’ care.^[31] The implementation of the new preoperative protocol led to an increase in the number of patients arriving at the hospital on the day of an operation and decreased the DOS cancellation rate significantly in cases where the “patient did not show up”. The total DOS cancellation rate at the hospital was 4.7%.^[9]

2.3 Ethical approval

The University Committee on Research Ethics evaluated the ethical aspects of this research and stated that the research was scientifically justified (25/2014). The university hospital granted permission to conduct the research (1/2015).

2.4 Data collection and analysis

This was a retrospective cross-sectional cost evaluation study. Data were collected from the hospital’s invoicing system with the hospital account manager’s assistance. The data were linked with DOS cancellation rates and reasons col-

lected from an administrative database for surgical patients for the period from September 1, 2015 to May 31, 2016.^[9] Costs of cancellations are reported in euros in terms of total waste and savings.

Table 1. Research reporting costs of surgery cancellations (years 2007-2017)

Source	Research site	Cost indicator and data collection	Outcomes	Cost of a cancellation per patient
Fitzsimons et al., 2016. USA	General hospital Cardiac patients	Wasted OR time Jan 2010 – Dec 2013	5110 scheduled cases, 43 cancellations (0.84%). The cancellations resulted in 89 hours and 34 minutes of wasted OR time. The most commonly referenced average cost of unstaffed OR time is 62 US dollars/minute. This value would add 333 188 US dollars to the costs of the cancellations.	333,188/43 = 7,748.60 US dollars
Sebach et al., 2015. USA	An evidence-based NP-managed preoperative evaluation clinic	Nurse-led preoperative assessment October to December 2013 and October to December 2014	Pre: 2,789 completed surgeries and 77 cancellations. Post: 2,372 planned surgeries and 36 cancellations. The lost revenue from 77 surgical cancellations was \$386,033. The lost revenue from 36 surgical cancellations was \$184,480. 329,784 scheduled surgeries, 40,988 cancellations (12.4%).	(386,033 + 184,480)/(77 + 36) = 5,048.80 US dollars
Argo et al., 2009. USA	123 Veterans Health Administration medical centers 9 specialties	Wasted OR time per year 2006	The cost of unused OR time in the VA has been estimated at \$600 per hour in 2009 dollars (total OR cost divided by work hours minus material costs). Cancellations of elective surgical cases are inefficient and costly to the VA system, with a 1.4% CR leading to an estimated loss of more than 32 million US dollars in 2006.	10 US dollars/OR suite minute
Pohlman et al., 2012. USA	Outpatient surgery center, 318-bed tertiary care pediatric hospital Urology	Results were calculated from hospital and physician data as the average surgeon fee for the planned surgical procedure plus the average hospital facility fee per minute based on planned surgical time January to July 2010	114 cancellations out of 854 scheduled procedures during the study period. The potential lost revenue for cancelled outpatient pediatric urology procedures averaged \$4,802 per cancellation, with an estimated \$500,000 in lost revenue during the 7-month study period.	4,802 US dollars
Bhuiyan et al., 2017. South Africa	One main operation theatre	The cost of inpatient stay January to December 2014	537 booked patients and 239 cancellations (44.5%). The cost per inpatient per day was estimated at ZAR 4,890 at PTB Hospital and ZAR 2,100 at district hospitals, and the total cost per cancelled operation was ZAR 25,860. The cost incurred due to cancellations was approximately ZAR 6 million for the hospital, with additional cost and emotional trauma for the patients.	ZAR 25,860 = 1,894.56 US dollars (13.4.2017 exchange rate)
Perroca et al., 2007. Brazil	Surgical center of a public teaching hospital 1,600 large-, medium- and small-size surgeries/mo	Cancellations after the preparation of the surgery room and during the surgery (materials, fees, medication and human resources) Three consecutive months in 2004	58 (23.3%) of the 249 cancelled scheduled surgeries represented costs for the institution. The cancellations’ direct total cost was R\$1,713.66 (average cost per patient R\$29.54). Materials R\$333.05 Sterilization process R\$201.22 Medications R\$149.77 Human resources R\$1,029.62 Human resources costs represented the greatest percentage in relation to total cost (60.40%).	Average cost per patient R\$ 29.54 29.54 US dollars (18.4.2017 exchange rate)
Macario, 2010. USA	Editorial comment about costs of operating room time		“Excluding physician costs, OR administrators may use a ballpark number such as \$15 to \$20 per OR minute for a basic surgical procedure.”	15-20 US dollars/OR minute

2.4.1 Procedure prices

Mean cost prices of operative procedures were collected from the hospital's invoicing system for the year 2016 in euros. The price of a procedure is calculated as mean costs of similar procedures during one year. There is no profit in the price as the hospital works as a non-profit institution. The price of a single operation consists of anesthesia resources, recovery room, implants, surgeon, medicine, environment (OR + OR staff), special equipment (e.g., a surgery robot) and specialty specific equipment. The cost of a cancellation was defined as resources that were reserved for the scheduled surgery for a specific patient. The model of calculation was that in case of a DOS cancellation, those resources could not be used for other purposes. DOS cancellation costs were calculated from the total cost of a procedure as follows:

DOS cancellation cost = total cost of a procedure – saved unused products

Saved unused products = implants + medicine + specialty specific equipment

DOS cancellation cost includes = anesthesia resources ± recovery room ± surgeon ± environment ± special equipment

DOS cancellation costs were reported in 13 operative specialties in euros in means, total costs, and by cancellation reason

during the nine-month study period. The invoicing system did not provide the procedure price in 33 cases. Missing data were replaced by specialty specific means of savings and costs.

3. RESULTS

Total costs of cancellations are presented in Table 2. The total cost of 542 elective surgery cancellations in 13 operative specialties was 953,374.27 euros in the nine-month study period, and the saving of material costs was 106,917.33 euros. The mean loss from a single cancelled operation was 2,459.91 euros, and the mean saving was 174.47 euros. The highest mean losses were found in cardiac and thoracic (4,539.93 €) and vascular surgery (3,016.82 €), and the lowest were found in ophthalmology (1,026.87 €) and urology (1,315.58 €). However, because of the number of cancellations in ophthalmology, the total loss was one of the highest (165,326.50 €) after orthopedics (212,565.65 €) and neurosurgery (165,416.39 €). Mean savings per cancelled operation were highest in gastrointestinal surgery (409.54 €), cardiac and thoracic surgery (399.90 €), vascular surgery (338.63 €), and neurosurgery (313.72 €). Some specialties did not achieve any savings, or savings were minor; these included dental surgery (0.19 €), plastic surgery (10.78 €), and pediatrics (18.36 €).

Table 2. Costs and savings of DOS cancellations (n = 542) by operative specialties, September 1, 2015-May 31, 2016

Medical specialty	Cancellations	Missing data		Cost per cancellation	Cost per cancellation, range	Saving per cancellation	Saving per cancellation, range	Total cost of cancellations	Total saving of cancellations
	(n)	(n)	(%)	(mean €)	(€)	(mean €)	(€)	(€)	(€)
Gastrointestinal surgery	24	2	7.7	1,945.52	799.22 – 5,738.55	409.54	130.30 – 1,003.79	46,692.38	9,828.96
Pediatrics	17	2	11.8	1,510.54	929.52 – 2,888.52	18.36	0 – 188.04	25,679.12	312.15
Hand surgery	14	1	7.1	1,495.49	998.75 – 2,374.01	113.29	0 – 636.29	20,936.91	1,586.08
Cardiac & thoracic	11	3	25	4,539.93	1,532.25 – 6,679.74	399.90	19.76 – 861.26	50,890.33	4,821.23
Urology	17	-	-	1,315.58	822.23 – 1,724.01	24.42	0 – 182.93	22,364.90	415.08
Vascular surgery	20	3	15	3,016.82	1,829.63 – 5,682.92	338.63	49.48 – 588.42	60,336.41	6,772.51
Neurosurgery	73	2	2.7	2,265.98	1,157.88 – 4,858.70	313.72	0 – 914.43	165,416.39	22,901.64
Gynecology	28	7	25	1,519.92	873.04 – 3,862.10	140.07	0 – 448.72	42,557.89	3,921.91
Ophthalmology	161	7	4.3	1,026.87	459.42 – 2,403.26	188.17	0 – 920.44	165,326.50	30,296.06
Ear, nose and throat	69	1	1.4	1,343.10	690.16 – 5,712.41	74.87	0 – 460.27	92,673.74	5,165.75
Dental surgery	10	1	10	2,459.91	626.80 – 3,064.51	0.19	0 – 0.28	24,599.11	1.86
Orthopedics	88	3	3.4	2,415.52	1,206.18 – 5,363.11	236.21	0 – 936.22	212,565.65	20,786.30
Plastic surgery	10	1	10	2,333.49	1,238.27 – 8,274.29	10.78	0 – 54.56	23,334.94	107.80
Total Hospital	542	33	6.1	2,459.91	459.42 – 8,274.29	174.47	0 – 1,003.79	953,374.27	106,917.33

Table 3. Cost of DOS cancellations (n = 542) by reason and operative specialty, September 1, 2015-May 31, 2016

Medical specialty	Patient did not show up		Resource-related reasons (no time for operation/rush, equipment unavailable, a surgeon unavailable, bed not available)		Patient unfit for operation (patient unsuitable for operation or anesthesia)		No need for operation		Other reasons (non specific reasons or administrative mistakes)	
	Cancellations	Cost	Cancellations	Cost	Cancellations	Cost	Cancellations	Cost	Cancellations	Cost
	(n)	(€)	(n)	(€)	(n)	(€)	(n)	(€)	(n)	(€)
Gastrointestinal surgery	-	0	10	11,849.83	11	31,668.03	2	2,001.66	1	1,172.85
Pediatrics	3	4,398.92	1	1,504.01	8	10,207.53	4	6,695.11	1	2,873.55
Hand surgery	2	3,884.87	-	0	8	11,620.15	4	5,431.90	-	0
Cardiac & thoracic	-	0	2	8,588.80	7	35,278.25	-	-	2	7,023.28
Urology	-	0	6	8,659.37	4	4,565.76	4	4,920.33	3	4,219.44
Vascular surgery	-	0	8	20,762.93	7	24,115.60	3	8,489.47	2	6,968.41
Neurosurgery	-	-	36	79,018.96	17	50,223.27	12	22,291.46	8	13,882.69
Gynecology	1	1,144.26	7	10,316.46	11	17,064.26	6	10,080.27	3	3,952.63
Ophthalmology	9	11,600	41	38,762.45	74	67,681.15	34	46,477.20	3	4,853.22
Ear, nose and throat	3	3,312.49	12	19,405.58	26	32,368.02	25	33,385.35	3	4,202.31
Dental surgery	1	3,064.51	3	7,621.58	4	8,388.61	-	0	2	5,524.42
Orthopedics	4	10,591.77	48	118,193.52	21	49,808.99	7	173,44.65	8	16,626.72
Plastic surgery	1	8,274.29	1	1,333.77	5	8,423.57	3	5,303.31	-	0
Total Hospital	24	46,271.11	175	326,017.26	203	351,413.19	104	162,420.71	36	71,299.52

Regarding cancellation reasons (see Table 3), the most costly reason was patients' unsuitability for the planned operation (n = 203), causing a total loss of 351 413.19 euros. The largest shares of this cost were in ophthalmology (67,681.15 €), neurosurgery (50,223.27 €) and orthopedics (49,808.99 €). Resource-related reasons (n = 175) caused the loss of 326,017.26 euros, including the largest losses in orthopedics (118,193.52 €) and neurosurgery (79,018.96 €). In 104 cases, patients were determined not to need the planned operation, leading to a total loss of 162,420.71 euros for the hospital; the highest shares in euros were found in ophthalmology (46,477.20 €) and ear, nose and throat (33,385.35 €). During the study period, there were 24 occasions when the patient did not show up at the hospital. These cancellations caused the loss of 46 271.11 euros, and the largest shares were in ophthalmology (11,600 €) and orthopedics (10,591.77 €). Other unspecified reasons led to a loss of 71,299.52 euros; the largest shares were in orthopedics (16,626.72 €) and neurosurgery (13,882.69 €).

4. DISCUSSION

The aim of this study was to measure the financial cost of DOS cancellations in a university hospital's 13 operative specialties after the hospital implemented an evidence based structured preoperative protocol.^[9,31] According to the results, DOS cancellations caused a financial loss of nearly a million euros during the nine-month study period. To the best of our knowledge, this is the first academic study to measure

the financial costs of surgery cancellations in Finland, and it supports previous estimates of the financial costs of elective surgery cancellations.^[5,6]

Several factors, such as country and specialty, are recognized to affect the costs of cancellations.^[13] The mean cost of a cancellation was approximately 2,500 euros, which is approximately half the cost of a cancellation in the US.^[33-35] By specialty, the cost of a single DOS cancellation was highest in cardiac and thoracic and vascular surgery and lowest in ophthalmology. By reason for cancellation, a major loss was related to hospital resources and patients' suitability for the planned surgery. This finding suggests that a cancellation rate under 2% may be achieved.

DOS cancellations became less usual among many specialties but when total amount of cancellations was calculated in hospital-level, the result was distorted by the high frequency of cancellations in ophthalmic surgery. This was due to their process which was different from other specialties and did not include a preoperative visit to confirm the need of surgery. To use their OR resource effectively, they developed a system for rapid recruitment of additional patients for each day. During the study a new reporting system was created to support each department to further decrease their cancellations. Unfortunately, our study has no follow-up in this matter.

There are several limitations to this study, and the results are suggestive. As the data were collected from the hospital's invoicing system that is not originally designed for research

purposes. However, the register may be seen as a reliable register including high quality data. It provides information that can be used for study purposes. To strengthen the analysis the assistance and participation of the hospital account manager was used. Financial causes of DOS cancellations are calculated as the mean costs of procedures over a year-long period. Procedure prices are limited in intraoperative care and do not include preoperative tests and care or postoperative care and hospitalization. In some cancellation cases a new patient may have been operated instead of a cancelled patient, but this was not considered in this study. Cancellation costs do not include any compensation paid to patients by the hospital. The reliability of this study might have been increased by using supportive data considering OR time used and minute-based costs,^[13] as in previous studies.^[32-34] However, reliable information about the use of OR time by operative specialty was not available for research purposes. The financial loss of DOS cancellations would best be measured in the standard manner using multiple supportive data sets.

The results of this study may be used to estimate the financial cost of DOS cancellations to organizations and to compare financial losses caused by elective surgery cancellations be-

tween different health care providers. Financial costs of DOS cancellations are a valid outcome measurement when setting goals and evaluating outcomes in a perioperative setting.

5. CONCLUSIONS

As a conclusion, DOS cancellations cause unnecessary wastage for health care organizations. Financial aspects should be followed and evaluated systematically by setting goals and providing continuing developments for optimizing health care expenses.

ACKNOWLEDGEMENTS

We would like to acknowledge accounting manager Heini Koskenvuori, M.Sc. (Econ.), who helped with evaluating the usefulness of databases and disseminating funds, the North Savo Hospital District Ministry of Social Affairs and Health, and Kuopio University Hospital Research Foundation. We thank the Finnish Foundation for Nursing Education for making this research possible through funding.

CONFLICTS OF INTEREST DISCLOSURE

The authors declare they have no conflicts of interest.

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