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Evidence for marked underutilization of insurance billing in malignant pleural mesothelioma in Finland

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Abstract

Background: Substantial variation in health care costs for malignant pleural mesothelioma (MPM) has previously been identified.

Materials and Methods: We analyzed the changes in health care costs in MPM in Finland during 2002–2012. Finland has low-threshold public health care and a mandatory Workers' Compensation scheme that covers all occupational-related disease expenses. The costs include treatment costs for inpatients, hospice care, medication costs, rehabilitation costs, and travel costs. All costs are expressed in 2012 prices, adjusted using the consumer price index.

Results: A total of 907 MPM patients were included in the study. Mean duration of inpatient episodes increased 7% per year from 2002 to 2012, correlating with total costs ($R^2 = 0.861$, $p < 0.05$). The annual total costs for treatment increased from 1.7 to 4.3 m€ during the study period and the cost per patient from 27 000 to 43 000 €. The overall costs increased progressively by the number of procedures performed. In patients who had been compensated for occupational cause by Workers' Compensation Center, only 36% of the overall care costs were billed from the insurance company. Billing of inpatient costs was 86% in these patients.

Conclusion: During the study period, we found that the costs of MPM increased more than the average health care costs. This may be because of advanced diagnostic workup or more costly treatment (e.g., pemetrexed). Moreover, only one-third of all health care costs are charged to Workers' Compensation Insurance.

KEYWORDS
asbestos, health care costs, malignant pleural mesothelioma, occupational disease

INTRODUCTION

Malignant pleural mesothelioma (MPM) is a rare cancer that is linked to previous occupational exposure to asbestos.[1,2] Because of the long latency period between asbestos exposure and MPM, the peak incidence is expected in 2020–2030 in Western countries.[3] The prognosis in MPM is generally poor, 5-year survival rate ranging from 10% to 12%,[3] although substantial survival diversity has been reported, because a proportion of patients exceeds survival over 5 years.[4,5] The incidence of MPM continues to rise globally, despite asbestos usage diminishing markedly since the 1980s.[6,7] The overall financial impact of cancer on society has been of increasing interest,[8] especially MPM, which is caused mainly by occupation-related factors.[9]

MPM is usually diagnosed in its advanced stage, where current treatment options include chemotherapy and radiotherapy. Only selected patients are candidates for radical

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surgery.[10] A previous nationwide study reported that 44% of MPM patients underwent either a diagnostic or therapeutic surgical procedure in Finland between 2000 and 2012.[11] The number of patients treated with chemotherapy and/or radiotherapy was 440 and 167, respectively. Pemetrexed was officially approved for use in Finland in September 2004 by the Finnish Medicines Agency (Fimea), but the usage started somewhat earlier through clinical trials. In the group of 440 patients treated with chemotherapy, 269 received pemetrexed in some form, either as a single agent or in combination with some other agent. The role and extent of therapeutic surgery for mesothelioma are under debate, and over the past decade there has been a shift from extrapleural pneumonectomy (EPP) to less extensive pleurectomy/decortication (PD).[12]

In 2019, Borrelli et al.[1] performed a systematic literature review focusing on the cost of MPM and identified nine studies examining costs. They estimated that the total cost of inpatient care in 2014 in the US was USD$41 709 687, and the mean inpatient cost was USD$24 901. The approaches varied from cost of illness studies to assessment of health care costs. In addition, there are differences in cost assessment methodologies and the studies have considered different years, which makes comparison difficult. Reported episode costs globally per MPM patient have varied from USD$18 812[13] to 67 000 €.[14] In France, medication costs comprised 31% of total costs and 66% of diagnosis-related group (DRG) costs.[15]

Fewer studies have reported developments in MPM costs over time. Cancer treatment methods are evolving rapidly, and it is important to assess these changes in relation to total costs. Our study cohort comprised 1010 patients diagnosed with MPM in Finland during 2000–2012, and the treatment and outcomes of these patients have been published earlier.[11] The objective of this study was to analyze changes in health care costs of mesothelioma in Finland in 2002–2012 and to evaluate reasons for rising costs.

MATERIALS AND METHODS

Study population and data collection

The study evaluated health care costs of mesothelioma at a population level. Cancer registry data was obtained for the years 2000–2012. The data from the Finnish Cancer Registry are considered accurate and of high quality; these we confirmed in our previous study.[16] Recent quality assessments showed 96% completeness for solid tumors.[17] Based on cancer registry IDs, treatment and cost data were obtained from the Care Register for Health Care administrated by the National Institute for Health and Welfare of Finland. The Care Register for Health Care contains data on all outpatient visits and inpatient periods, including diagnosis (International Classification of Diseases [ICD]-10) and procedures (with no maximum number), in publicly funded health care organizations. Comprehensive cost data from the registry were available for the years 2002–2012. These registries are mandated by law and provide a full coverage of hospital admissions. In addition, healthcare costs in total were collected from National Institute for Health and Welfare of Finland. All costs are expressed in 2012 prices, adjusted using the consumer price index.[18]

The funding of Finnish healthcare system is mixed. The share of public funding was 75.8% (16.0 billion €) in 2018 and the share of private funding was 24.2% (5.1 billion €).[19] Since 1948, Finnish workers have been covered comprehensively by the National Workers' Compensation Act, which is facilitated by independent insurance companies: in 2020, 12 independent companies and two national agencies. Revisions to legislation were made in the years 1982, 1993, and 2016. Costs of occupation-related diseases should be fully compensated by the insurance companies to health care service providers, and enhanced social security for long-term disability and pension is also provided for affected persons. Because there is a growing discussion of the affordability of publicly funded health care, we wanted to study how the compensation works in practice and if the costs are also covered by public tax funding.

We identified MPM patients via the Finnish National Cancer Registry by diagnosis code (ICD-10 classification) and cross-referenced these patients with the National Workers' Compensation Center Registry to identify patients with known accumulated costs by private and public insurance sectors. These costs include treatment costs for patients in hospitals, hospice care, medication costs, rehabilitation costs, and travel costs. Additional cost data were gathered from the Care Register for Health Care of the National Institute for Health and Welfare collectively in January 2017. These costs comprise all medical costs from 1 month before MPM tissue diagnosis to death or last known contact with health care. Every hospital episode and outpatient visit, including also other diagnoses, were linked with DRG costs.

This was a retrospective register study; therefore, no informed consent was required, and participants were not contacted. The legal basis for processing personal data is public interest and scientific research (EU General Data Protection Regulation 2016/679 (GDPR), Article 6 (1) (e) and Article 9 (2) (j); Data Protection Act, Sections 4 and 6).

Methods

The duration of a health care episode was defined as the difference between the start of the first inpatient episode and the discharge of the last inpatient episode. Inpatient days were calculated as the difference between the day of discharge and the admission day of each admission. The costs of public treatment and compensated costs outside the hospital for patients were summed. The costs of both inpatient and outpatient medications could not be separated individually, therefore, they are included in the total costs. The total cost per patient was estimated and the costs are reported based on the year that treatment began.

The patients were allocated to the following procedure groups based on their surgical operation: (1) surgery,

(2) palliative or diagnostic procedure, and (3) no procedure. Surgical treatment included EPP, PD, and partial pleurectomy.[20] Patients with palliative procedure had either indwelling pleural catheter insertion/removal, surgical pleurodesis without tumor removal, or bronchus/esophageal stent insertion. Diagnostic procedures comprised surgical or radiological biopsy, bronchoscopy, or another diagnostic endoscopy. Patients were categorized by the most invasive procedure if several operations were performed.

The results were statistically analyzed using Student's *t*-test. The level of statistical significance was set at 0.95% ($p < 0.05$). For the time series, a linear regression model was used. Statistical analyses were undertaken using SPSS. The results are presented as mean with standard deviation or median with 10% and 90% percentiles because those values are for descriptive analysis of the variance instead of statistical analysis of differences.

RESULTS

A total of 907 MPM patients were included in the study. The national incidence varied between 63 and 95 patients per year without a clear trend (Figure 1). The number of patients alive with disease increased until the year 2007 and then stabilized until 2012.

The average duration of inpatient episodes increased 7% per year between 2002 and 2012 (Figure 2). This, together with the growing number of mesothelioma patients, explains the rising number of patients in treatment in Figure 1. The median number of overall inpatient days per patient during the treatment was 41 days and interquartile range (IQR) 39 days and there was no systematic change in inpatient days between the years. The duration of inpatient care correlated significantly with the overall costs of patients (Figure 3, $R^2 = 0.7073$).

Total costs for mesothelioma treatments increased from around 1.7 m€ (real 2.0 m€) to 4.3 m€ in the 10-year observed period, and the real cost per patient rose from around 27 000 to 43 000 € (Table 1). The share of inpatient episodes was 86% of the total costs. The cumulative annual growth rate (CAGR) was 9.7% for total costs and 4.9% for cost per patient. The costs did not increase evenly; a notable increase in costs occurred in 2005.

For the whole study period, the median cost per patient was 26 400 € and the average cost 36 600 €. The total costs

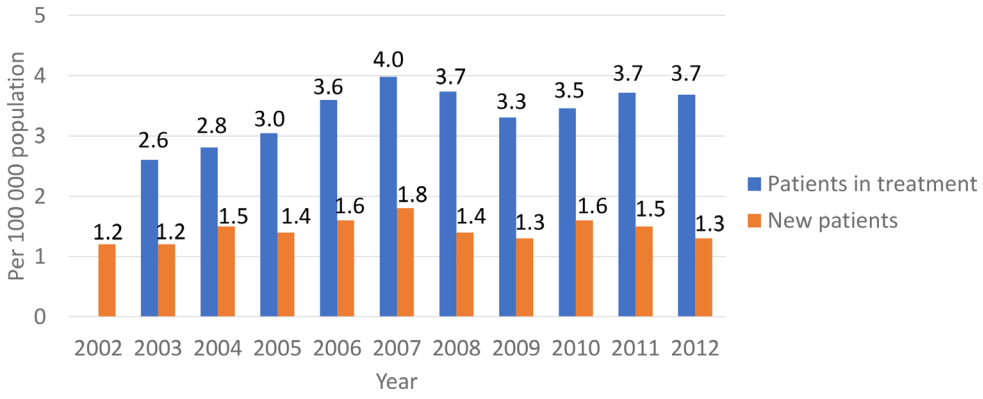

FIGURE 1 Incidence of new malignant pleural mesothelioma patients and patients in treatment per 100 000 inhabitants in Finland in 2002–2012

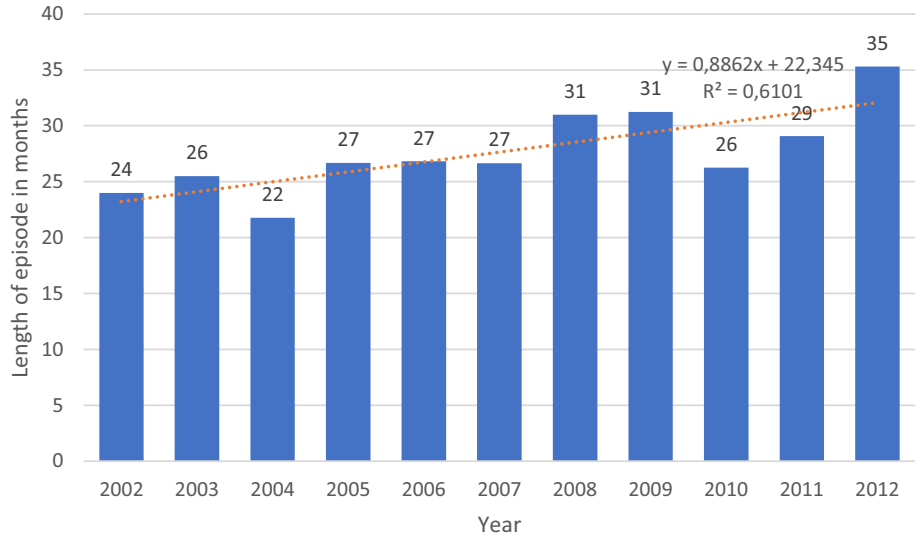

FIGURE 2 Total length of health care episode for malignant pleural mesothelioma patients in Finland in 2002–2012. The duration of a health care episode was defined as the difference between the start of the first inpatient episode and the discharge of the last inpatient episode

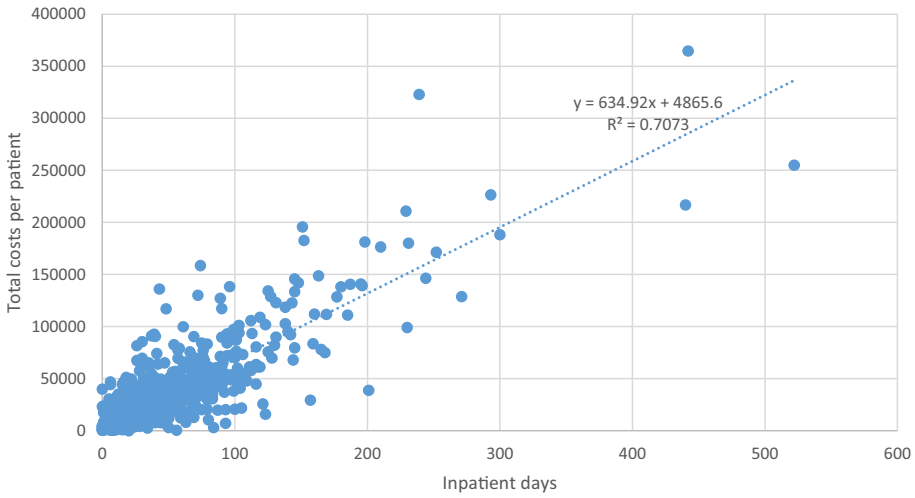

FIGURE 3 Correlation of total costs and inpatient days per malignant pleural mesothelioma patient in Finland 2002–2012

TABLE 1 Total healthcare costs, treatment costs, and costs per patient for malignant pleural mesothelioma in Finland in 2002–2012

Year	Total healthcare costs (m€)	Total treatment costs for mesothelioma (€)	Share of mesothelioma costs (%)	Treatment costs per mesothelioma patient (€)
2002	13 493	1 681 174	0.015	26 685
2003	14 225	2 054 970	0.017	32 108
2004	15 081	1 706 918	0.013	21 073
2005	15 951	3 000 593	0.022	41 674
2006	16 449	2 506 700	0.018	29 490
2007	16 942	2 929 677	0.019	30 838
2008	17 449	3 463 907	0.021	44 985
2009	17 924	3 790 792	0.023	55 747
2010	18 294	3 454 953	0.020	40 646
2011	18 774	3 588 878	0.020	43 239
2012	19 271	4 280 643	0.022	42 951[a]

Note: All costs are real costs in 2012 values.
[a]Treatment costs per patient for the year 2012 are only partially captured because the care episodes may continue during the following years.

exceeded 50 000 € in 20% of patients and their share of the total costs was 50% (Table 2). The Workers' Compensation insurance covered only 36% of the overall care costs for the patients with verified MPM as an occupational disease (5.6 m€). However, for patients who had over 10 000 € compensated through Workers' Compensation, the rate of compensation increased to 54.0% of the overall expenses. Overnight inpatient fees were compensated at a rate of 86% from Workers' Compensation. The median total cost for patients with occupational disease was 25 898 € (8342–65 949 €), and the total cost did not differ compared with non-occupational patients (median 27 534, 7136–72 513 €).

The overall costs increased with the complexity of the procedures performed (Table 3). The differences between all groups were statistically significant. In addition, the costs of patients undergoing surgical procedure were higher than the costs of patients with palliative or diagnostic procedure only. Of the most expensive patients, 32 (34%) patients were belonging to "surgery" segment, 30 patients to "palliative or diagnostic procedure" segment and 33 (35%) to "no procedure" segment. High patient-level costs were more related to number of inpatient days than the costs of procedures.

DISCUSSION

The economic burden of malignant diseases can be divided into direct (i.e., health care costs) and indirect costs.[8] This study explores the changes in health care costs in mesothelioma patients diagnosed in Finland between 2002 and 2012. The average increase in health care costs during the study period was 3.6% according to the National Institute of Health and Welfare.[21] In mesothelioma patients, the total costs increased over twofold faster than the average health care costs. Similarly, we found that the overall cost for treatment more than doubled during the 10-year study period. There are several explanations for this phenomenon. For example, the duration of inpatient episodes and the

TABLE 2 Distribution of malignant pleural mesothelioma patients based on cost per patient category in Finland 2002–2012

Cost per patient (€)	Patients	Total costs (€)	Share of patients (%)	Share of costs (%)
0–9999	132	734 593	15	2
10 000–19 999	191	2 926 799	21	9
20 000–29 999	178	4 342 533	20	13
30 000–39 999	126	4 312 393	14	13
40 000–49 999	95	4 241 489	10	13
50 000–59 999	51	2 762 783	6	8
60 000–69 999	39	2 499 036	4	8
70 000	95	11 374 198	10	34

TABLE 3 Costs according to the most extensive procedure/operation performed on malignant pleural mesothelioma patients in Finland 2002–2012

	Surgery	Palliative or diagnostic procedure	No procedure
No. of patients	148	327	185
Median cost per patient (€)	38 906	29 511	20 952
Fractile (10%–90%)	14 811–112 849	11 216–66 546	5038–60 256
Mean cost per patient (€)	52 331	36 535	30 519
Standard deviation	49 685	29 494	36 275
Days of hospital stay, median (range 10%–90%)	47 (18–107)	40 (13–97)	32 (8–90)

prognosis of MPM patients had increased. Both diagnostic examinations and treatment practices have evolved during the study period.

Our study group has previously reported that 55% of MPM patients were classified as occupational disease, and therefore, would be entitled to cost compensation.[11] This figure is probably an underestimation of the true work-related disease because it has earlier been estimated that over 80% of mesothelioma cases are because of asbestos exposure, with occupational exposure being the most common.[22–24] Here, we observed that compensated patients had only one-third of total costs covered by insurance. One reason for the discrepancy could be that although inpatient fees are mostly covered automatically, a proportion of the outpatient costs need to be claimed afterward by the patient. Further, the compensation should also cover mesothelioma-related costs, which cannot be distinguished from the total costs. As noted in the study by Laaksonen et al.,[11] 7.8% of patients were diagnosed at autopsy. Finnish legislation mandates that suspected work-related deaths must be examined forensically; therefore, some occupational diseases are only recognized after the patient had died. In the end, these figures suggest that underreporting of both occupational diseases and cost claims had occurred during the study period. Protocols for claiming occupational disease-related costs vary by hospital, but are commonly dependent on the actions of individual physicians and other personnel and may, therefore, be prone to registering errors. However, we think that currently these figures are higher because many hospitals have trained social workers and sophisticated occupational medicine clinics to ensure that patients receive the benefits they deserve.

The reported costs per patient in our study are similar to the reported costs in earlier studies. A study of the cost of mesothelioma in Italy during 2002–2015 estimated the per patient cost to be 67 000 €.[14] The average annual per patient cost burden of mesothelioma in France was estimated at 33 422 €.[15] Here, the average cost for the study period was 36 600 €. However, the overall costs were not distributed evenly; 20% of patients shared 50% of the total costs. This finding is in line with other reports on cancer patients.[25]

Because most MPM patients receive systemic therapies at some point of the disease, medications contribute substantially to the cost burden of mesothelioma.[10,26] The costs of both inpatient and outpatient medications are included in the total costs, and therefore, cannot be specified. However, there is a clear increase in costs in 2005, and we consider that the addition of pemetrexed to the standard chemotherapy regimen could explain part of this increase. Pemetrexed was officially approved for use in Finland in September 2004 by the Finnish Medicines Agency (Fimea).[27] In our cohort, 269 patients received pemetrexed either as a single agent or in combination.[11] Borelli et al.[1] reviewed the medical care for MPM and calculated that the total cost of six cycles of single pemetrexed was over 100 times higher than that of cisplatin. Other than pemetrexed, the medical treatment options have not changed notably during the study period. However, as novel treatments with increased efficacy will emerge in the clinical practice, the medication costs are expected to increase substantially in the near future.[28]In addition to treatment, surgical interventions play an important role in the diagnosis, staging, and palliative management of MPM.[12,20] At least during the study period in Finland, multimodality treatment approaches were not used,

and therefore, patients undergoing surgery would receive another treatment only after possible recurrence of the tumor.[29] There were no major changes in procedures performed during the study period, and EPP was the most common curative intent surgery. In line with previous studies,[1] we found that the total costs were associated with the extent of the surgical procedure. Indeed, the costs almost doubled in patients undergoing either curative intent or cytoreductive surgery relative to patients with no procedures. There are several explanations for this association. The patients undergoing surgical treatment have a rigorous diagnostic workup with several hospital visits before the operation.[30] Especially after EPP, the length of postoperative care and complications are high.[31] In addition, according to register data, the average survival is longer in patients undergoing surgery than in patients without surgery.[32]

In this study, we analyzed the changes in health care costs of MPM in Finland between 2002 and 2012 by combining data from different registries. This approach has inherent limitations. First, the Finnish Cancer Registry does not reliably collect treatment data, and therefore, the doses and length of cancer care cannot be further investigated. We, therefore, did not specify treatments separately from the total costs. Similarly, diagnostic studies are not quantified. The procedures are recorded by the operation code, but no information is given on the extent and outcome of the surgery/procedure. This approach also has some benefits; we obtained comparative data for the 10-year study period and could, therefore, measure the longitudinal changes in total costs. Although the study period is not up to date, no major breakthroughs have occurred in the treatment of MPM.[33] In addition, we found shortcomings of our work compensation system. It does underreport some of the compensated costs because some patients received the occupational diagnosis at autopsy.

CONCLUSIONS

The costs of MPM increased more than the average health care costs during the study period. In addition, the length of treatment episodes has increased, resulting in higher total costs. This may be because of advanced diagnostic workup or more effective treatments. We also found out that only a portion of health care costs are charged to Workers' Compensation Insurance. Future studies should focus on changes in total costs in relation to the effectiveness of treatments. Our results provide health care workers and patients with clear and practical protocols for reimbursement.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

INSTITUTIONAL REVIEW BOARD STATEMENT

The study was conducted according to the guidelines of the Declaration of Helsinki and the study protocol was approved by the local Institutional Review Board and the Ethics Committee of the Hospital District of Helsinki and Uusimaa (418/13/03/02/2015). Approval to use the data was received from the Finnish National Institute for Health and Welfare, the National Workers' Compensation Center, and Statistics Finland.

INFORMED CONSENT STATEMENT

Patient consent was waived because of the retrospective nature of the research.

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