The cost impact for hospitals of using Pedatim® in rehabilitation of patients who have undergone abdominal cancer surgery

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Executive Summary

Early mobilization after surgery is well-recognized to enhance recovery and improve patient outcomes. However, it is also known that most patients do not have adequate physical activity post-surgery (until discharge). Scandinavian Phystec AB (Phystec) has developed a novel software activity board (Pedatim®) for patients that need rehabilitation in hospital, short stay care and home care. Studies that have evaluated Pedatim has found that including it in addition to standard of care can enhance early mobilization and reduce length of hospital stay.

To assess the impact of incorporating Pedatim into routine post-operative rehabilitation practice, a cost-impact model was developed. This model compares the effect of using Pedatim for patients that have undergone cancer surgery in addition to standard of care (mobilization activities ordinated by a physiotherapist) in comparison with only standard of care. The model flexible in terms of altering input values (number of surgeries per year, effectiveness in reducing LOS and costs) to update the analysis when new data is available.

The result shows that Pedatim is a cost-saving strategy for patients in need of early mobilization activation (rehabilitation) after major abdominal cancer surgery. The cost-savings are evident in all subgroups evaluated (bladder, colon, rectal and ovarian cancer) and in all regions. For every increase in the number of patients treated per year the cost-savings with Pedatim increases. Additional results shows that the proportion of patients that need to have a treatment response with Pedatim for the result to be cost-saving is also low for all possible subgroup scenarios (5% of all patients in the example provided in the result section; Region Skåne and colon cancer). In summary, this cost-impact model indicates that Pedatim is a cost saving rehabilitation tool for patients that have undergone major abdominal cancer surgery in Sweden.

1. Background

Lower abdominal cancer includes cancer of the colon, rectum, ovaries, and bladder which is among the most commonly diagnosed cancer types in Sweden (1). For these cancer types, abdominal surgery that aims to remove the tumour is still today the most common type of first-line cancer treatment, in combination with chemotherapy and often radiation therapy (1, 2). Abdominal surgery can be associated with post-operative complications such as pneumonia, atelectasis, respiratory insufficiency, intra-abdominal bleeding and surgical-site infections which can increase the le (3, 4). In addition, less severe complications after surgery include urinary tract infection, fever, bedsores, fatigue, nausea and vomiting (4, 5).

Post-operative rehabilitation that includes early mobilization and functional activities after cancer surgery is a well-recognized practice to enhance recovery and improve patient outcomes (6). It is also thought to impact the risk of developing post-operative complications (1). In Sweden, the importance of physical activity before, during and after cancer treatment is emphasized in the standardized care pathways for (standardiserade vårdförlopp) for colon, rectum, ovaries, and bladder cancer (3, 7, 8). Furthermore, early mobilization after surgery is highlighted in the Enhanced recovery after surgery (ERAS) protocols (6). However, it is recognized that patients do not get adequate level of physical activity post-surgery (1).

Phystec Scandinavia AB (Phystec) has developed a novel software activity board (Pedatim®) for patients that need rehabilitation in hospital, short stay care and home care (9). Pedatim is accessible for patients and health care personnel via a touch screen next to the bed. The benefit of Pedatim as an active rehabilitation tool has been assessed in several recent studies at the Karolinska Institute (4, 10-13). The main effect of using Pedatim is that patients get more involved in their own rehabilitation. This is done by using a scientifically proven method to support behaviour change which involves four success factors; clear goals, feedback, visual interface, and rewards (all integrated in Pedatim's interface) (1). Moreover, it is also a supportive tool to for health care professional as it comes with a structured format to ordinate mobilization activities and monitor the rehabilitation progress (12). In a study by Porserud et al. (2019) Pedatim was proven to increase early mobilization and reduce length of hospital stay (LOS) for patients that have undergone major abdominal cancer surgery (11). To assess the impact of incorporating Pedatim into routine post-operative rehabilitation practice, a cost-impact model was developed.

2. The cost-impact model

2.1 Scope of the analysis and use

This model compares the effect of using Pedatim for patients that have undergone cancer surgery in addition to standard of care (mobilization activities ordinated by a physiotherapist) in comparison with only standard of care. The main results are expressed as the number of LOS days that potentially can be reduced with Pedatim and related health care costs. In addition, complementary analysis also investigates the number of steps required to reduce LOS with one day.

Pedatim is a rehabilitation tool with the possibility to be used for a wide range of patient populations in need of improving functional capacity (9). However, in this cost-impact model the focus is four subgroups of patients (patients with colon, rectal, ovarian and bladder cancer) which were included in a recent study by Porserud et al. (11), see Appendix 5.1 for a summary of the clinical study.

The cost-impact model (available as a spreadsheet Excel Workbook) is developed to be used at a regional level in Sweden. It can also be adapted to be used at the hospital level depending on the level of data used in the model. The analysis starts post-surgery at the specific department patients are treated in (e.g. the Urology department for patients with bladder cancer), Figure 1 below gives an overview of the model.

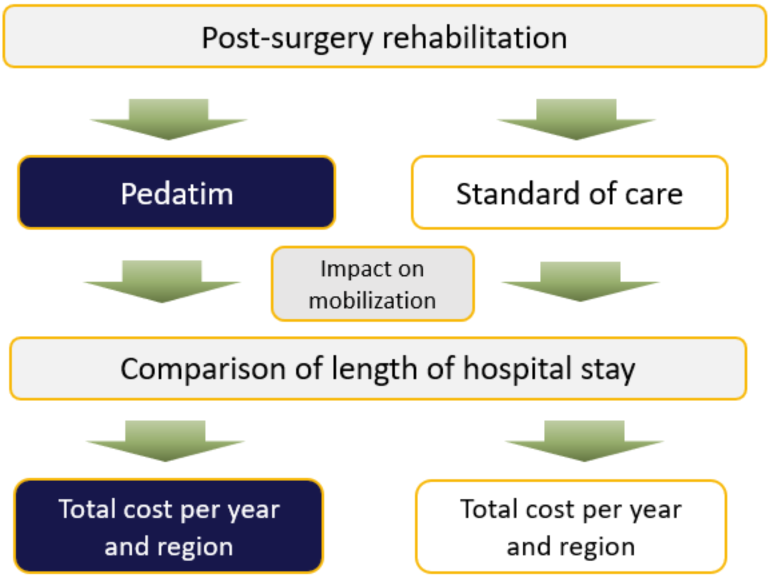

Figure 1. Overview of the cost-impact model for Pedatim

The user of the model starts by selecting region and patient population (colon, rectal, ovarian or bladder cancer) of interest. This is done to capture the total number of cancer surgeries performed each year in a specific region, Figure 2. The second step is the selection of cost parameters to be included (number of Pedatim units required and cost per LOS day (see section 2.2.4), Figure 3. In the analysis, the total LOS is then compared between Pedatim and standard of care until discharge.

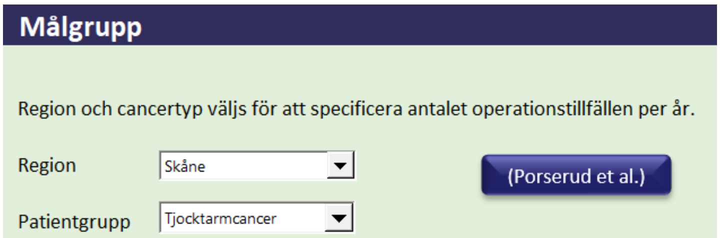

Figure 2. Selection of Region and cancer type (Patiengrupp in Swedish in the model)

Figure 3. Selection of cost parameters in the model (pricelist and number of Pedatim units)

2.2 Input values

2.2.1 Number of cancer surgeries per year

The number of cancer surgeries that are expected in each region in a year is based on data from Swedish National Quality Registers through an open-source database provided by Regional Cancer Centers in Sweden (Regionala cancercentrum, RCC). For colon and rectal cancer, data on the number of cancer surgeries that was reported to the Swedish Colorectal Cancer Registry (Kolorektalcancerregistret, SCRCR) in year 2022 is available for all regions in Sweden (14, 15), see Appendix section 5.2.

Regarding the number of surgeries per region for patients with bladder cancer, data was obtained from the Swedish bladder registry (Svenska nationella kvalitetsregistret för Urinblåse- och urinvägscancer (SNRUBC)) (16). The most common surgery type for bladder cancer is transurethral resection of bladder tumor (TURB). This type of surgery can be performed without hospitalization that exceeds one day or the patients need to be hospitalized for up to 2-3 days (17). In the study by Porserud et al., patients with bladder cancer had either a cystectomy or an Urinary diversion *ad modum* Bricker of which the latter is less commonly used to treat cancer (11). From the SNRUBS registry, data was available for the number of cystectomies only. However, data were not available for five regions, see Appendix section 5.2.3. To estimate the number of surgeries for regions with missing data, regional population data was used to calculate the average number of surgeries per capita in those regions where data were available and then use this average ratio (number of surgeries per capita) to estimate the annual number of surgeries for the remaining regions, see Appendix section 5.2.3.

The number of surgeries for ovarian cancer were obtain from the Swedish Quality Registry for Gynecologic Cancer, SQRGC (18). Ovarian cancer is commonly categorized as having cancer in the ovaries or in adject areas (namely the fallopian tube and peritoneum) (19). Therefore, these types of diagnosis were used, including borderline tumour in the ovaries[1]. Data was not available for four regions, see Appendix section 5.2.4. To estimate the number of annual surgeries for regions with missing data the same method as outlined for bladder cancer was used.

The total coverage rate of the reported surgeries in year 2022 was 98% for colon cancer, 96% for rectal cancer, and 93% for bladder and ovarian cancer. To adjust for a low coverage rate (in this case defined as a coverage rate of <97%) the number of surgeries expected to be registered given a 100% coverage rate was estimated. This was done by obtaining the ratio of number of surgeries reported for each surgery protocol registered and multiplying the ratio with the expected number of surgery protocols (as reported in the quality registry database). For every region where the reported coverage rate was <97% the estimated number of surgeries given a 100% coverage rate was used, see Appendix 5.2. The model allows the user to select other values for the number of surgeries per year.

2.2.2 Length of hospital stay (LOS)

This section describes how average LOS were estimated for subgroups in the analysis and how the effect of reducing LOS with Pedatim is incorporated.

In the study by Porserud et al. (2019) median LOS were summarized for patients having Pedatim in addition to standard of care and patients only with standard of care. For patients treated with Pedatim the median LOS was 6 days (min 3 days and max 13 days) and 7 days for patients treated only with standard of care (min 3 days and max 14 days) (11). The difference in LOS between Pedatim in addition to standard of care in comparison with only standard of care was statistically significant (p-value = 0.027). However, data on average LOS is not available for the subgroups in the study by Porserud et al. Therefore, a method was developed to estimate this based on the reported median values of LOS for the whole study population and complementary sources from the literature. The method is described below:

Step 1: Estimation of mean LOS for the whole study population (Porserud et al.)

We used a gamma distribution to simulate percentile values of LOS in the range 1 to 99 (where percentile 50 corresponds to the median). The gamma distribution has two parameters, alpha and beta, which are estimated based on the population mean and standard deviation (SD)[2]. The starting point for the simulation (simulation 1) was to have mean value equal to the median value when estimating alpha and beta (see results in Appendix section 5.3) and the simulation process continued until we had an estimate of alpha and beta that generated a median value that corresponded to what was reported in the study by Porserud et al. (11). For both Pedatim and standard of care, we did four simulations where the mean value gradually increased from 7.0 to 7.3 (standard of care) and 6.0 to 6.3 respectively

[1] Borderline tumours in the ovaries are treated according to the same principles as invasive epithelial ovarian cancer (20).

[2] Alpha is given by (mean/SD)^2 while Beta is given by SD^2/Alpha.

(Pedatim). At 7.3 days the gamma distribution generated values of alpha (7.047) and beta (1.036) which resulted in a median value that corresponded to 7.0 (standard of care in Porserud et al.). The same was done for Pedatim; at 6.3 days the gamma distribution generated values of alpha (6.350) and beta (0.992) which generated a median value that corresponded to the Porseryd study's 6.0, see Appendix section 5.3.

The effect of reducing LOS with Pedatim was then calculated with the following formula: $(\frac{7.3-6.3}{7.3} = 0.14)$. A 14% reduction in LOS with Pedatim was applied in all subgroup analyses to the estimated mean LOS as described in step below.

Step 2: Estimation of LOS for subgroups in the analysis

To obtain mean values of LOS for the different subgroups, a correlation coefficient of the number of steps and LOS from the study by Porserud et al. was used (0.324) (11). The method consisted of estimated values of LOS given an interval of number (from 0 to 13000). This was done by following two criteria; 1) the estimated LOS values should equal to a correlation coefficient as the one reported in the Porserud study, 2) the mean values of all estimated LOS datapoints should correspond to mean values of LOS reported in the literature for the different cancer types, see Table 1. The correlation coefficient was obtained by using an exponential regression and taking the square root of the R2 value. In summary the estimated mean LOS for the different cancer types was 9.5 days for bladder cancer, 3.9 days for colon and rectal cancer and 6.0 days for ovarian cancer.

Table 1. Summary of length of hospital stay for the subgroups of patients derived from the literature

	Length of hospital stay	Average value (assumption)	LOS used in the model[2]	Source
Bladder cancer[1]	8-14 days	10	9.5	(21)
Colon and rectal cancer	3-6 days	4	3.9	(22)
Ovarian cancer	4-14 days	6	6.0	(23)

[1] Includes only surgical removal of the bladder (cystectomy). [2] Estimated values based on the method described in this section.

2.2.3 Relationship between LOS and number of steps

One additional analysis in the cost-impact model estimates the total number of steps required to reduce LOS with one day for the different subgroup of patients. This analysis uses the obtained regression equation in step 2 outlined in section 2.2.2 for each cancer type. The regression equation is used to depict what number of steps (x-values) is necessary to produce a reduction in LOS of one day (y-values). See result section 3.2 for a graphical illustration of this analysis.

2.2.4 Cost inputs

There are two cost inputs in the analysis, the cost for the clinic to use Pedatim and cost of LOS per day.

2.2.4.1 Cost of using Pedatim

The cost of using Pedatim follows a volume-based tariff which consist of a monthly subscription cost depending on the number of Pedatim units that the clinic uses. For example, if the clinical decides to use only one unit of Pedatim, the monthly cost is 1400 SEK as compared to 1200 SEK if three units are used.

The cost-impact model uses an optimization function to calculate the number of Pedatim units required given the annual number of patients that undergo surgery in the selected region per year and the number of possible rehabilitation days in a year. It is assumed that surgeries are performed in a total of 42 weeks in a given year, corresponding to a total of 294 possible days for surgery and post-operative rehabilitation with Pedatim).

An example of how the number of Pedatim units required each year is calculated is given below:

Example
In Region Skåne, a total of 525 patients had a surgery for colon cancer in year 2022.

Step 1: $\frac{525}{294} = \mathbf{1.786} \rightarrow$ Number of surgeries per active day.

Step 2: $\mathbf{1.786 * 4 = 6.87} \rightarrow$ Number of Pedatim units required (given an average LOS of 4 days).

Step 3: Rounding 6.87 up to closest whole number yields 7 Pedatim units.

Given the price tariff for Pedatim, the cost of having 7 Pedatim units is 92 400 SEK per year.

A summary of the number of Pedatim units required given annual number of surgeries for each cancer type is given in Figure 4. Note that not all possible scenarios (annual number of surgiers) in the model are included in this figure but it reflects the interval of the number of Pedatim units that in most cases will be required (given what the model estimates). For instance, the annual number of colon surgeris in Region Skåne was 525 in year, this corresponds to a total of 7 Pedatim units required. The reason why the number of Pedatim units required differs between the subgroups is due to different values in average LOS used in the analysis (see Table 1). For instance, patients with ovarian cancer are estimated to have an average LOS of 8.16 days with Pedatim[3] as compared with only 3.3 days for colon cancer. This means that the likelihood is higher that more patients will be hospitalized and in the rehabilitation process simultaneously if the average LOS is longer.

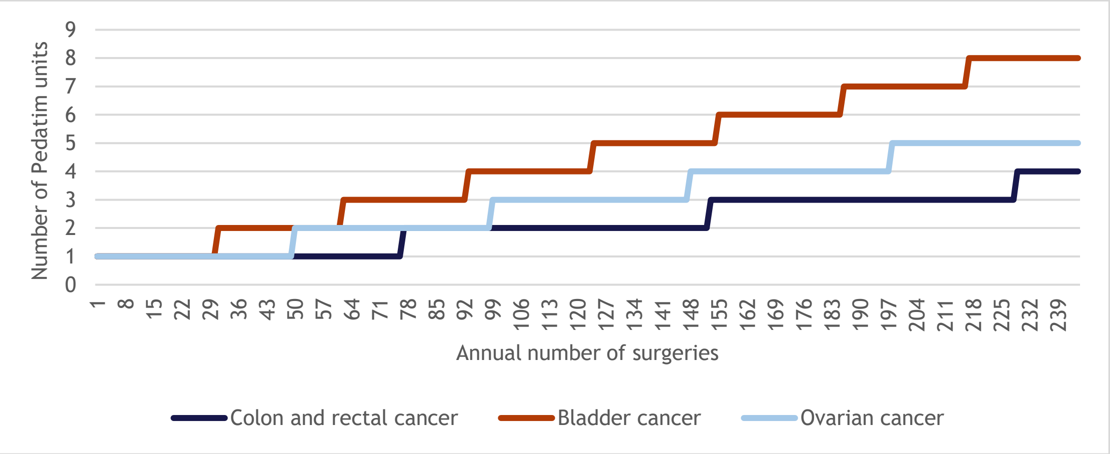

Figure 4. Number of Pedatim units required for a given annual number of cancer surgeries each year for (separated by cancer type)

[3] Average LOS for bladder standard of care is estimated to 9.5 and 3.85 for colon cancer. 8.16 and 3.3 is obtained by applying the effect of reducing LOS of 14% with Pedatim.

2.2.4.2 Cost per hospital stay

The cost per hospital stay for each patient is in analysis based on unit costs for LOS day which is derived from a price list published by the south health care region in Sweden (Södra Sjukvårdsregionen) (24), Table 2.

Table 2. Cost per day hospitalized used in the analysis (sourced from Södra Sjukvårdsregionen (24)

Deptarment	Cost per day hospitalized
Urology	4965 SEK
Gastroenterology	6962 SEK
Gynecology	7283 SEK

3. Results

In this section the results are given for the following settings in the cost impact models:

- Region: *Skåne*
- Subgroup: *Colon cancer*
- Cost per LOS day: *6962 SEK*
- Number of Pedatim units required: *7*[4]
- Number of possible rehabilitation days in a year: *294 days*

3.1 Cost comparison

In Figure 5 below the total cost for hospital stay in a year is given for patients (n=525) with colon cancer in Region Skåne. For patients treated with Pedatim in addition to standard of care the total length of stay is 1733 days and for only standard of care it is 2022 days. This corresponds to a difference of 289 days in a year. In Figure 6 the result is given for an average patient.

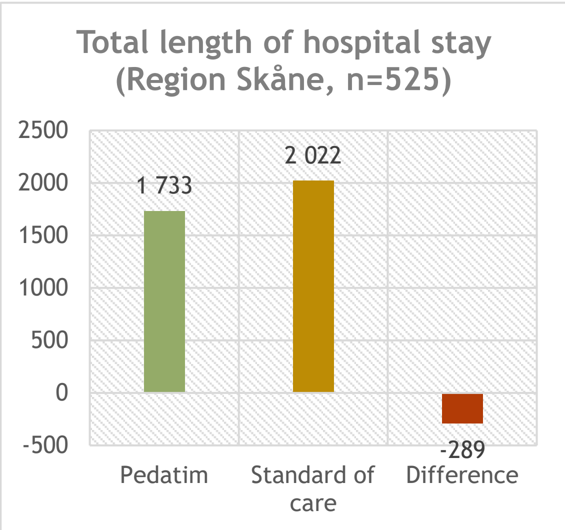

Figure 5. Total length of hospital stay in a year for patients (n=525) with colon cancer in Region Skåne

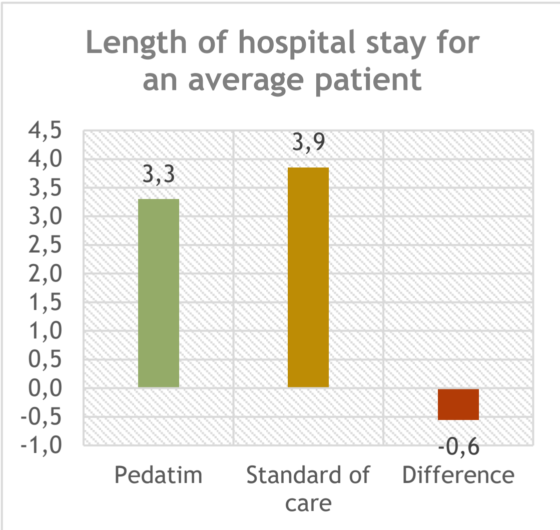

Figure 6. Length of hospital stay in a year for an average patient with colon cancer in Region Skåne

In Figure 7, the total cost per year is given for the same analysis settings. The cost of length of hospital stay (health care costs) is 12,159,867 SEK for patients treated with Pedatim and 14,078,711 for patients treated only with standard of care. The difference of 2,011,244 SEK is a result of the reduction in LOS days with Pedatim (289 days). The cost of using Pedatim for a total of 525 patients equals to 92,400 SEK which corresponds to a total of 7 Pedatim units. The total cost savings per year of using Pedatim amounts to around 1.9 million SEK (1,918,844).

[4] The number of Pedatim units is estimated with an optimization function, see example in section 2.2.3.1

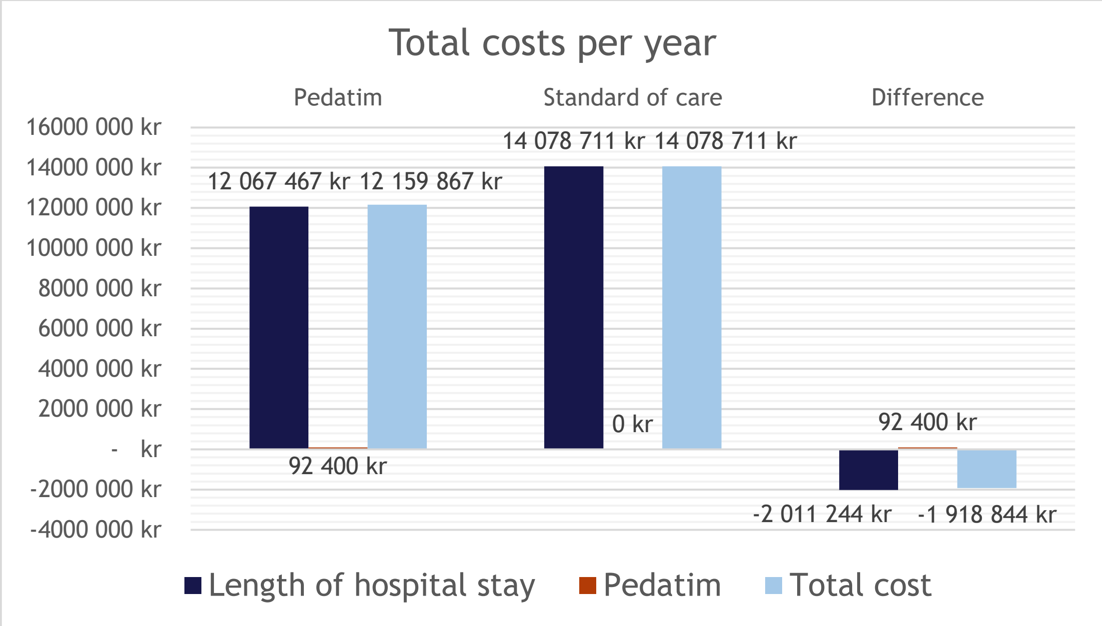

Figure 7. Total cost per year (n=525) for patients with Pedatim and only standard of care (Region Skåne and colon cancer)

In Figure 8, the same result is given for an average patient based on the total patient population (n=525 and 7 Pedatim units). The result shows that if the total patient population use Pedatim, the cost savings per patient is equal to 3655 SEK.

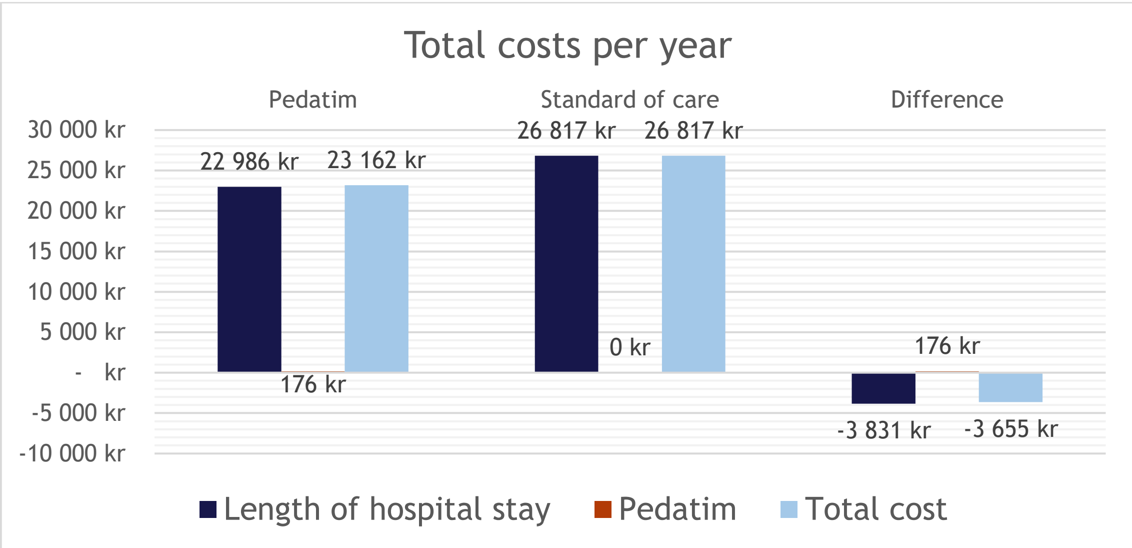

Figure 8. Cost per year for an average patient for patients with Pedatim and only standard of care (Region Skåne and colon cancer)

In all possible subgroup analyses (when region and cancer type are altered) the result for the total number of surgeries per year shows that including Pedatim in routine clinical practice results in cost-savings for the clinic. The larger the subgroup population is (e.g. if a larger region is selected such as Region Stockholm in comparison with Region Örebro), more hospital days can be reduced with Pedatim and consequently the cost-savings will be larger. The cost of using Pedatim can be the same even though the annual number of surgeries is different. For instance, in Region Kronoberg there were 81 colon surgeries in year 2022 which results in a need of 1.06 Pedatim units and in Region Jönköping 1.96 Pedatim units are estimated based on 150 annual surgeries. In both these cases, two Pedatim units will be required, which corresponds to a cost of 33 600 SEK per year. This means that the Pedatim units would be more efficiently used in Region Jönköping. However, since the cost of Pedatim units is relatively low in comparison with the cost of LOS (1.8 million SEK in Region Kronoberg and 3.4 million SEK in Region Jönköping), the cost of one extra unit of Pedatim that might not be used efficiently is negligible.

One other way of evaluating the robustness of the result in terms of the threshold when Pedatim is a cost-saving strategi is by looking at what proportion of patients treated with Pedatim that needs to respond to the intervention. Given the example used in this section (Region Skåne and colon cancer), 5% of all patients treated with Pedatim (out of 525 patients) need to respond to the treatment (meaning a 14% reduction in LOS) to have a cost saving result. If the annual number of surgeries are lower (e.g. number of surgeries for ovarian cancer in Region Gävleborg; 20) 14% of all patients treated with Pedatim need to respond to the treatment to have a cost saving result.

3.2 Number of steps required to reduce LOS with one day

In Figure 9 below the result is shown for patients with colon or rectal cancer, which indicates that an average patient needs to take approximately 7000 steps to reduce LOS with one day (7000 steps is equal to around 3.2 LOS days). This results in around 2200 steps per day. The same method was used to estimate the number of steps required to reduce LOS with one day for bladder (3500 steps), and ovarian cancer (5500 steps). These results should be interpreted with caution as data on LOS and number of steps stratified by subgroups were not available from the study by Porserud et al. (11). In addition, this only shows the result for an average patient, and it does not take individual differences in patient characteristics into account.

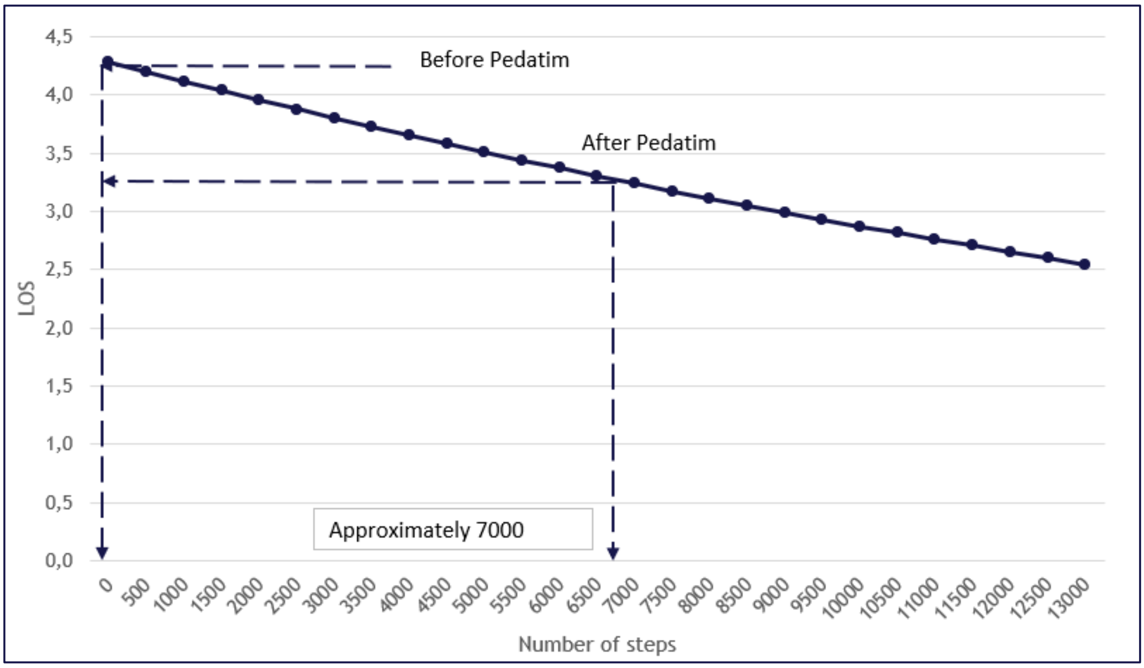

Figure 9. Illustration of the number of steps required to reduce LOS with one day for patients with colorectal cancer.

4. Discussion

This cost-impact model shows that Pedatim is a cost-saving strategy to be used in addition to standard of care for patients in need of early mobilization activation (rehabilitation) after major abdominal cancer surgery. The cost-savings potential is evident in all subgroups evaluated (bladder, colon, rectal and ovarian cancer) and in all regions. For every increase in the number of patients treated per year (after five patients) the cost-savings with Pedatim increases. Additional results shows that the proportion of patients that need to have a treatment response with Pedatim for the result to be cost-saving is also low for all possible subgroup scenarios (5% of all patients in the example provided in the result section; Region Skåne and colon cancer).

Overall, interventions with the potential of reducing LOS at a relatively low cost is favourable to any health care system to reduce health care spending and in many cases also waiting times. This cost-impact analysis of Pedatim adds to existing evidence of cost-effectiveness of rehabilitation interventions. The cost-impact model of Pedatim is flexible in terms of altering input values (number of surgeries per year, effectiveness in reducing LOS and costs) to update the analysis when new data is available. However, it is somewhat challenging to compare the impact of Pedatim on health care resource utilization with other interventions since the overall evidence around the cost-effectiveness of rehabilitation strategies post-surgery is scarce. In terms of enhanced recovery after cancer surgery, one meta-analysis found that the use of the ERAS-protocol (which promotes early mobilization post-surgery before discharge) may reduce LOS compared to conventional recovery (25). One systematic literature review (SLR) by Abeles et al. found a positive association between physical activity post-surgery time (not cancer specific) and fewer days in hospital (26). One more recent SLR and meta-analysis found that wearing an activity trackers for patients hospitalized (not cancer specific) significantly improved the level of physical activity but the association with LOS did not reach statistically significance (27).

One limitation with this cost-impact analysis is the lack of LOS data for the subgroups of patients that were included in the study by Porserud et al. (11). Instead, the analysis had to rely on complementary sources from the literature and the correlation coefficient between LOS and number of steps in the study by Porserud et al. (21-23). The lack of subgroup data is also a limitation in the analysis on the number of steps required to reduce LOS with one day. One other aspect not captured in the cost-impact model is the association between early mobilization and risk of post-surgery complications. One recent SLR and meta-analysis found a positive association between physical active interventions and a decrease in the rate of adverse events in comparison with usual care at discharge (included acutely hospitalised older adults not cancer specific) (28). One study on patients undergoing major abdominal surgery found a positive association between daily step count and the incidence of complications (5).

Even though it is well recognized that increasing physical activity post-surgery can enhance recovery, the optimal level of physical activity required is far less understood. The additional analysis that evaluated the number of steps required to reduce LOS with one day explores the possible use of a single metric on mobilization for this purpose. However, this analysis was not able to correlate other parameters (e.g. differences in patient characteristics) that possibly also could explain the association between number of steps and LOS days. For instance, it is likely that the physical activity level at baseline (before surgery) and the overall health state is also correlated to the extent of how many steps a patient can take post-surgery before discharge. Further subgroup results could possibly be generated by initiating research collaborations between academic hospitals and Scandinavian Phystech to study the benefits of early mobilization with Pedatim in real clinical practise. Obtaining patient-level data could further be utilized to optimize the use of Pedatim and rehabilitation programs.

In summary, this cost-impact model shows that Pedatim is a cost-saving intervention to be used after cancer surgery by improving adherence to ordinated mobilization activities and thereby enhancing the speed of recovery. In addition, there are also likely to be additional benefits with Pedatim not captured in this analysis. For instance, Pedatim can possibly reduce the workload among health care professionals by facilitating the ordination of activities to patients and aid in the information transfer process and follow-up between different health care teams.

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5. Appendix

5.1 Summary of study by Porserud et al. (2019)

In the clinical study by Porserud et al., effects on mobilization and postoperative recovery after abdominal cancer surgery were assessed for Pedatim and standard of care (11). A total of 133 patients were included in the study at KI.

Table 3. Demographic and clinical characteristics of study population in Porserud et al. (11).

	Pedatim (n=67)	Standard of care (n=66)
Age, mean (sd)	69.3 (11,4)	67.0 (13,1)
Diagnosis, n (%)		
Urinary bladder cancer	35 (52.5)	33 (50.0)
Colon cancer	11 (16.4)	8 (12.1)
Rectal cancer	7 (10.4)	6 (9.1)
Ovarian cancer	14 (20.9)	19 (28.8)
Oncological treatment before surgery	21 (31.3)	25 (37.9)
Surgical technique		
Lower midline incision	10 (14.9)	18 (27.3)
Upper and lower midline incision	19 (28.4)	12 (18.2)
Robotic assisted laparoscopic	38 (56.7)	36 (54.5)

A summary of the result in terms of mobilization is given in Table 4 below.

Table 4. Summary of of result from Porserud et al. (11)

	Pedatim	Standard of care	P-value
Lying in bed, (min/day)	1062 (528-1380)	1140 (168-1434)	0.019
Upright, (min/day)	78 (6-528)	42 (0-282)	0.006
Standing, (min/day)	60 (6-366)	42 (0-240)	0.010
Walking, (min/day)	18 (0-162)	6 (0-84)	0.002
Total upright[1], (min/day)	282 (60-774)	234 (12-1074)	0.048
Sitting[1], (min/day)	198 (30-606)	150 (6-942)	0.098
Steps, (n)	1057 (3-10433)	360 (0-6546)	0.001
Transitions from sit to stand, (n)	16 (4-70)	12 (1-61)	0.015

Total upright = sitting + standing + walking, [1] n = 105 (55/50).

5.2 Number of cancer surgeries per region and year

The data used for the number of cancer surgeries per region is summarized in this section.

5.2.1 Colon cancer

The coverage rate is provided for all regions which is defined as the number of surgery protocols reported to the the registry in comparison with the expected number of cases reported to the National Cancer Registry. All regions have a coverage rate above 97% apart from Region Dalarna (91%) and Region Halland (94%), Table 5. To adjust for a low coverage rate (defined as a coverage rate <97%) the number of surgeries expected to be registered given a 100% coverage rate was estimated. This was done by obtaining the ratio of number of surgeries reported for each surgery protocol registered and multiplying the ratio with the expected number of surgery protocols (as reported in the database).

Table 5. Number of colon cancer surgeries per region in year 2022, coverage rate of reported cases and estimated number of cases

Region	Number of surgeries (year 2022)	Coverage rate	Number of surgeries per surgery protocol	Estimate number of surgeries if coverage was 100%[1]
Blekinge	58	97%	0.88	NA
Dalarna	116	91%	0.87	127
Gävleborg	120	100%	0.92	NA
Gotland	34	100%	0.94	NA
Halland	154	94%	0.92	163
Jämtland	59	100%	0.98	NA
Jönköping	150	97%	0.99	NA
Kalmar	126	100%	0.94	NA
Kronoberg	81	98%	1.03	NA
Norrbotten	106	100%	0.91	NA
Örebro	131	100%	0.92	NA
Östergötland	173	98%	0.96	NA
Skåne	525	97%	0.97	NA
Sörmland	118	100%	0.91	NA
Stockholm	695	99%	0.90	NA
Uppsala	111	100%	0.90	NA
Värmland	96	100%	0.94	NA
Västerbotten	108	99%	0.99	NA
Västernorrland	98	97%	0.92	NA
Västmanland	128	100%	0.88	NA
Västra Götaland	702	99%	0.98	NA
RIKET	3895	98%	0.94	NA

[1] Only estimated for those regions where the coverage rate was <97%.

5.2.2 Rectal cancer

Three regions have a coverage rate below 90% (Region Dalarna; 87%, Region Gotland; 88% and Region Jönköping; 85%). For every region where the reported coverage rate was <97% the estimated number of surgeries given a 100% coverage rate was used (same method as outlined in section 5.2.1).

Table 6. Number of rectal cancer surgeries per region in year 2022, coverage rate of reported cases and estimated number of surgeries

Region	Number of surgeries (year 2022)	Coverage rate	Number of surgeries per surgery protocol	Estimated number of surgeries if coverage was 100%[1]
Blekinge	23	93%	0.92	25
Dalarna	30	87%	0.56	34
Gävleborg	36	100%	0.73	NA

Gotland	6	88%	0.86	7
Halland	53	96%	0.82	55
Jämtland	9	90%	1.00	10
Jönköping	46	85%	0.92	54
Kalmar	38	98%	0.90	NA
Kronoberg	27	100%	0.90	NA
Norrbotten	31	83%	0.79	37
Örebro	39	100%	0.74	NA
Östergötland	65	97%	0.89	NA
Skåne	158	91%	0.90	174
Sörmland	36	98%	0.72	NA
Stockholm	218	98%	0.74	NA
Uppsala	33	100%	0.57	NA
Värmland	36	100%	0.68	NA
Västerbotten	33	100%	0.89	NA
Västernorrland	31	100%	0.79	NA
Västmanland	47	100%	0.77	NA
Västra Götaland	291	97%	0.90	NA
Total	1289	96%		

[1] Only estimated for those regions where the coverage rate was <97%.

5.2.3 Bladder cancer

To adjust for a low coverage rate (<97% the same method as outlined in section 5.2.1 was used). Data was not available for five regions (Region Blekinge, Halland, Jämtland, Norrbotten and Sörmland). The result of the estimated number of cystectomies for regions with missing data is available in Table 8.

Table 7. Number of cystectomies per region in year 2022, coverage rate of reported cases and estimated number of surgeries

Region	Number of surgeries (year 2022)	Coverage rate	Number of surgeries per surgery protocol	Estimate number of surgeries if coverage was 100%[1]
Blekinge	NA	100%	NA	53
Dalarna	11	99%	0.12	11
Gävleborg	8	100%	0.08	NA
Gotland	5	100%	0.22	NA
Halland	NA	75%	NA	NA
Jämtland	NA	100%	NA	NA
Jönköping	14	100%	0.13	14
Kalmar	15	100%	0.17	15
Kronoberg	7	100%	0.09	7
Norrbotten	NA	23%	NA	NA
Örebro	17	99%	0.18	17
Östergötland	22	73%	0.14	22

Skåne	82	100%	0.17	82
Sörmland	NA	96%	NA	NA
Stockholm	109	99%	0.18	111
Uppsala	16	98%	0.16	16
Värmland	10	100%	0.11	10
Västerbotten	16	99%	0.18	16
Västernorrland	17	98%	0.22	17
Västmanland	12	100%	0.15	12
Västra Götaland	52	89%	0.11	52
Total	413	93%		

[1] Only estimated for those regions where the coverage rate was <97%.

Table 8. Estimated number of cystectomies for regions with missing data in year 2022

Region	Number of cystectomies (year 2022)	Number of cystectomies per capita	Estimated number of cystectomies
Blekinge	NA	NA	8
Dalarna	11	0.00004	NA
Gävleborg	8	0.00003	NA
Gotland	5	0.00008	NA
Halland	NA	NA	16
Jämtland	NA	NA	6
Jönköping	14	0.00004	NA
Kalmar	15	0.00006	NA
Kronoberg	7	0.00003	NA
Norrbotten	NA	NA	12
Örebro	17	0.00006	NA
Östergötland	22	0.00005	NA
Skåne	82	0.00006	NA
Sörmland	NA	NA	14
Stockholm	109	0.00004	NA
Uppsala	16	0.00004	NA
Värmland	10	0.00004	NA
Västerbotten	16	0.00006	NA
Västernorrland	17	0.00007	NA
Västmanland	12	0.00004	NA
Västra Götaland	52	0.00003	NA

5.2.4 Ovarian cancer

To adjust for a low coverage rate (<97% the same method as outlined in section 5.2.1 was used). Data was not available for five regions (Region Blekinge, Halland, Jämtland, Norrbotten and Sörmland). The result of the estimated number of cystectomies for regions with missing data is available in Table 10.

Table 9. Number of ovarian surgery per region in year 2022, coverage rate of reported cases and estimated number of surgeries

Region	Number of surgeries (year 2022)	Coverage rate	Number of surgeries per surgery protocol	Estimate number of surgeries if coverage was 100%[1]
Blekinge	0	NA	NA	NA
Dalarna	26	96%	1.0	27
Gävleborg	20	97%	0.7	21
Gotland	0	NA	NA	NA
Halland	28	97%	1.0	29
Jämtland	0	70%	NA	NA
Jönköping	6	100%	0.2	6
Kalmar	8	96%	0.3	8
Kronoberg	9	94%	0.6	10
Norrbotten	0	67%	NA	NA
Örebro	16	91%	0.8	18
Östergötland	31	100%	0.6	31
Skåne	73	94%	0.7	77
Sörmland	12	100%	0.7	12
Stockholm	137	85%	1.0	162
Uppsala	19	97%	0.6	20
Värmland	21	96%	0.0	0
Västerbotten	0	100%	0.0	11
Västernorrland	11	96%	0.5	12
Västmanland	0	92%	0.0	0
Västra Götaland	108	99%	0.8	543
Total	525	93%		

[1] Only estimated for regions with a coverage rate of <97%

Table 10. Estimated number of surgeries per year for regions with missing data (ovarian cancer in year 2022)

Region	Number of surgeries per capita	Estimated number of surgeries
Blekinge	NA	7
Dalarna	0.000094	NA
Gävleborg	0.000072	NA
Gotland	NA	3
Halland	0.000085	NA
Jämtland	NA	6
Jönköping	0.000016	NA
Kalmar	0.000034	NA
Kronoberg	0.000047	NA
Norrbotten	NA	12
Örebro	0.000057	NA
Östergötland	0.000066	NA

Skåne	0.000055	NA
Sörmland	0.000040	NA
Stockholm	0.000066	NA
Uppsala	0.000049	NA
Värmland	0.000000	NA
Västerbotten	0.000000	NA
Västernorrland	0.000047	NA
Västmanland	0.000000	NA
Västra Götaland	0.000062	NA

5.3 Estimations of mean LOS

Table 11. Estimations of mean LOS based on simulated median LOS from gamma distribution (Pedatim)

	Simulation 1	Simulation 2	Simulation 3	Simulation 4
Percentiles	Mean value=6.0	Mean value=6.1	Mean value=6.2	Mean value=6.3
0.001	1.06	1.12	1.18	1.24
0.01	1.73	1.80	1.88	1.96
0.02	2.03	2.11	2.19	2.28
0.03	2.24	2.33	2.41	2.50
0.04	2.41	2.50	2.59	2.67
0.05	2.56	2.65	2.73	2.82
0.06	2.69	2.78	2.87	2.96
0.07	2.80	2.89	2.98	3.07
0.08	2.91	3.00	3.09	3.18
0.09	3.01	3.10	3.19	3.29
0.1	3.10	3.19	3.29	3.38
0.11	3.19	3.28	3.38	3.47
0.12	3.27	3.37	3.47	3.56
0.13	3.36	3.45	3.55	3.64
0.14	3.43	3.53	3.63	3.72
0.15	3.51	3.61	3.70	3.80
0.16	3.58	3.68	3.78	3.88
0.17	3.66	3.75	3.85	3.95
0.18	3.73	3.82	3.92	4.02
0.19	3.79	3.89	3.99	4.09
0.2	3.86	3.96	4.06	4.16
0.21	3.93	4.03	4.13	4.23
0.22	3.99	4.09	4.19	4.29
0.23	4.06	4.16	4.26	4.36
0.24	4.12	4.22	4.32	4.42
0.25	4.18	4.28	4.38	4.48
0.26	4.24	4.34	4.45	4.55
0.27	4.30	4.41	4.51	4.61
0.28	4.36	4.47	4.57	4.67

0.29	4.42	4.53	4.63	4.73
0.3	4.48	4.59	4.69	4.79
0.31	4.54	4.65	4.75	4.85
0.32	4.60	4.70	4.81	4.91
0.33	4.66	4.76	4.87	4.97
0.34	4.72	4.82	4.93	5.03
0.35	4.78	4.88	4.98	5.09
0.36	4.83	4.94	5.04	5.15
0.37	4.89	5.00	5.10	5.20
0.38	4.95	5.05	5.16	5.26
0.39	5.01	5.11	5.22	5.32
0.4	5.07	5.17	5.28	5.38
0.41	5.12	5.23	5.33	5.44
0.42	5.18	5.29	5.39	5.50
0.43	5.24	5.35	5.45	5.56
0.44	5.30	5.40	5.51	5.61
0.45	5.36	5.46	5.57	5.67
0.46	5.42	5.52	5.63	5.73
0.47	5.48	5.58	5.69	5.79
0.48	5.54	5.64	5.75	5.85
0.49	5.60	5.70	5.81	5.91
0.50	5.66	5.76	5.87	**5.97**
0.51	5.72	5.82	5.93	**6.03**

Table 12. Estimations of mean LOS based on simulated median LOS from gamma distribution (Standard of care)

	Simulation 1	Simulation 2	Simulation 3	Simulation 4
Percentiles	Mean value=7.0	Mean value=7.1	Mean value=7.2	Mean value=7.3
0.001	1.40	1.47	1.53	1.60
0.01	2.21	2.28	2.36	2.44
0.02	2.56	2.64	2.73	2.81
0.03	2.81	2.89	2.98	3.06
0.04	3.00	3.09	3.18	3.27
0.05	3.17	3.26	3.35	3.44
0.06	3.31	3.40	3.50	3.59
0.07	3.45	3.54	3.63	3.72
0.08	3.57	3.66	3.75	3.85
0.09	3.68	3.77	3.87	3.96
0.1	3.79	3.88	3.98	4.07
0.11	3.89	3.98	4.08	4.17
0.12	3.98	4.08	4.18	4.27
0.13	4.08	4.17	4.27	4.37
0.14	4.16	4.26	4.36	4.46
0.15	4.25	4.35	4.45	4.54
0.16	4.33	4.43	4.53	4.63

0.17	4.41	4.51	4.61	4.71
0.18	4.49	4.59	4.69	4.79
0.19	4.57	4.67	4.77	4.87
0.2	4.65	4.74	4.84	4.94
0.21	4.72	4.82	4.92	5.02
0.22	4.79	4.89	4.99	5.09
0.23	4.86	4.96	5.06	5.17
0.24	4.93	5.04	5.14	5.24
0.25	5.00	5.11	5.21	5.31
0.26	5.07	5.17	5.28	5.38
0.27	5.14	5.24	5.34	5.45
0.28	5.21	5.31	5.41	5.51
0.29	5.28	5.38	5.48	5.58
0.3	5.34	5.44	5.55	5.65
0.31	5.41	5.51	5.61	5.72
0.32	5.47	5.58	5.68	5.78
0.33	5.54	5.64	5.74	5.85
0.34	5.60	5.71	5.81	5.91
0.35	5.67	5.77	5.87	5.98
0.36	5.73	5.84	5.94	6.04
0.37	5.80	5.90	6.00	6.11
0.38	5.86	5.97	6.07	6.17
0.39	5.93	6.03	6.13	6.24
0.4	5.99	6.09	6.20	6.30
0.41	6.05	6.16	6.26	6.37
0.42	6.12	6.22	6.33	6.43
0.43	6.18	6.29	6.39	6.50
0.44	6.25	6.35	6.46	6.56
0.45	6.31	6.42	6.52	6.63
0.46	6.38	6.48	6.59	6.69
0.47	6.44	6.55	6.65	6.76
0.48	6.51	6.62	6.72	6.82
0.49	6.58	6.68	6.79	6.89
0.5	6.64	6.75	6.85	**6.96**
0.51	6.71	6.82	6.92	**7.02**