Forecasting and optimization of the kilovoltage X-ray therapy with Xstrahl300 within the framework of new clinical guidelines

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Purpose of the Study

• To investigate and forecast the load of the kilovoltage X-ray therapy unit after the implementation of new clinical guidelines;
• Determine the clinical and organizational changes in x-ray therapy for non-melanoma skin cancer within the day-hospital department for the skin cancer size >2 cm in compare with previously used schemes;
• Derive a mathematical model of the work of the kilovoltage x-ray therapy room.
“Of particular interest to the problem of optimal organization of work within the framework of clinical recommendations are radiotherapy rooms that provide medical care for non-melanoma skin cancer (NSC) due to the significant mass use of the treatment method and high incidence”
New clinical guidelines

<table>
<thead>
<tr>
<th>Tumor size</th>
<th>Single dose, Gy</th>
<th>Fractions</th>
<th>Total dose, Gy</th>
<th>Weeks</th>
<th>Time-Dose-Fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2 см</td>
<td>2</td>
<td>32</td>
<td>64</td>
<td>6-7</td>
<td>108</td>
</tr>
<tr>
<td></td>
<td>3,3</td>
<td>15</td>
<td>50</td>
<td>3-4</td>
<td>108</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>5</td>
<td>35</td>
<td>1</td>
<td>118</td>
</tr>
<tr>
<td>&gt; 2 см</td>
<td>2</td>
<td>33</td>
<td>66</td>
<td>6-7</td>
<td>111</td>
</tr>
<tr>
<td></td>
<td>2,75</td>
<td>20</td>
<td>55</td>
<td>4</td>
<td>108</td>
</tr>
<tr>
<td>Adjuvant radiotherapy</td>
<td>2</td>
<td>30</td>
<td>60</td>
<td>6</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>2,5</td>
<td>20</td>
<td>50</td>
<td>6</td>
<td>102</td>
</tr>
</tbody>
</table>
Patients routing with NMSC

- Morbidity for NMSC in Ekaterinburg region is 3000 patients in 2018;
- Skin cancer is 2^{nd}(13.2\%) on men and 3^{rd} (8.7\%) on women;
- Only 40\% of oncology patients in Russia got radiotherapy in 2018;
Correlation: N of X-ray sessions, length of hospital stay, patients treated

<table>
<thead>
<tr>
<th>Год</th>
<th>Пациентов</th>
<th>Посещений</th>
<th>Среднее количество сеансов РТ</th>
<th>Средний койко-день</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>533</td>
<td>5 529</td>
<td>10,4</td>
<td>12</td>
</tr>
<tr>
<td>2018</td>
<td>554</td>
<td>6 925</td>
<td>12,5</td>
<td>18</td>
</tr>
<tr>
<td>2019</td>
<td>728</td>
<td>12 594</td>
<td>17,3</td>
<td>24</td>
</tr>
</tbody>
</table>

The average number of therapeutic fractions in one patient when using new clinical guidelines increased from 10.4 to 17.3, which is 1.7 times more than in 2017.

An increase in the average number of radiation therapy sessions leads to an increase in the length of the patient's average bed-day in the day hospital (24 vs 12)
Patients’ planning

N of patients by one radiotherapist per working year

\[ a = \frac{N \times K}{n} \]

- \( a \) - the number of patients treated per year
- \( N \) - the number of calendar days per year (or any period of time)
- \( K \) is the number of patients per working day
- \( n \) - average bed-day

Patients admitted to the day care unit per week

\[ b = \frac{a \times 5}{Np} \]

- \( a \) - the number of patients treated per year
- 5 - 5 working days a week
- \( b \) - number of patients hospitalized per week
- \( Np \) - the number of working days in a year
Conclusions

• Changes in clinical guidelines, expressed in an increase in the number of fractions of radiation therapy, should be taken into account when planning patient waiting times for hospitalization, workload on staff and equipment;

• To ensure the optimal quality and availability of medical care, it is necessary to match treatment technologies with the available resources of the organization;

• The use of the proposed formulas makes it possible to predict and solve the basic problems of organizing the treatment process for NMSC X-ray therapy. The mathematical model of the operation of the X-ray therapy room makes it possible to predict the optimal mode of work of employees while maintaining the quality and availability of medical care.
Thank you!

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