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Cancer Treatment Protocol Set: Mobile Application Set the Treatment Regimens

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Abstract

The disproportion between the number of doctors and patients has exhausted physicians. Tumor specialists exert significant effort when setting treatment protocols, as these are determined by multiple factors such as age, grade, gender, weight, medical history, and more. Doctors require a simplified technique to establish treatment regimens, including dosage, treatment schedules, and the availability of drug combinations tailored to the patient's condition. This article introduces a Cancer Treatment Protocol Set (CTPS) system, designed to assist doctors in outlining the framework for the treatment journey. CTPS includes a database for storing patient information. It also helps doctors select specific treatment regimens, after which the system calculates medicine dosages, treatment days, and provides recommendations based on the patient's status. The CTPS supports treatment protocols for seven cancer types, including their required chemotherapy doses throughout the treatment journey. The application was developed using the Flutter platform. Dosages are calculated based on input data and pre-saved equations within the program. The system presents various treatment regimens for the supported cancer types, enabling doctors to choose the most suitable option. Additionally, patient data and scheduled regimens are stored on Google Sheets, ensuring easy accessibility for doctors.

Keywords: Cancer treatment protocol, treatment regimen, cancer type, chemotherapy dose, mobile app, health care

1.2 Introduction

Cancer is one of the most critical and complex diseases, requiring physicians to act promptly and decisively to improve the chances of curing the patient and minimizing complications[1–4]. The timely initiation of appropriate treatment plays a crucial role in managing cancer progression and improving patient outcomes. Among the various treatment methods, chemotherapy is a widely used and highly effective protocol. However, its implementation is not straightforward, as it is governed by multiple criteria[5–7]. Factors such as the patient's age, height, weight, gender, and the cancer's grade and stage significantly influence the determination of treatment doses and the design of personalized protocols[8]. In practice, physicians often rely on medical reference books, clinical guidelines, and standardized

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formulas to describe the appropriate drug regimens and establish a suitable treatment plan [9]. This process requires meticulous attention to detail and strict adherence to medical standards to ensure the safety and efficacy of the treatment. However, these calculations and protocol designs can become an overwhelming task, especially in healthcare systems burdened by a disproportionate ratio of patients to physicians[10]. The increasing workload, combined with the need to customize treatments for individual patients, leaves doctors exhausted and under significant time pressure. This situation is further exacerbated by the high prevalence of cancer cases and the limited availability of trained oncologists, resulting in delayed treatment initiation and increased stress on healthcare providers[11–14].

Supported applications help the doctors to save working time and to advance their performance because they will provide automated dose calculations and automated treatment regimens that differ according to the cancer type. Mobile health applications have emerged as highly effective and efficient tools for raising awareness and disseminating healthcare information. Studies indicate that these health-related apps are valuable and yield positive outcomes. By providing accurate and up-to-date information, mHealth apps have the potential to bridge knowledge gaps and empower individuals to take proactive steps in safeguarding their health [15]. A recent study by Hombaiah et al. explored the impact of mobile health (mHealth) applications on cervical cancer prevention knowledge and screening behavior among women in social support groups with low socioeconomic status in Mysuru City, Southern India[16]. The study found that the use of mHealth applications significantly improved cervical cancer awareness and screening rates in these communities. By providing accessible and relevant information, the mHealth intervention helped bridge the healthcare information gap and promoted proactive health behaviors, particularly among marginalized populations with limited access to traditional healthcare resources[16]. Ilana et al. explored the role of mobile health applications in providing psychological support to cancer patients. Their study demonstrated that mHealth apps offering cognitive-behavioral therapy (CBT) modules helped reduce anxiety and depression levels among cancer patients, contributing to better mental health and overall well-being[13].

In the literature review, three medical platforms—EasyMed[17], MedScape[18], and ONCO Assist[19]—highlight their respective functionalities. EasyMed emerges as the most comprehensive platform, offering capabilities such as a dose calculator, printing support, a directory, electronic patient record integration, and news updates, along with support for medical consultations across six diseases. MedScape, while slightly less extensive, supports some diseases and provides additional features like a calculator, directory, podcasts, and a robust medicine interaction checker. However, it lacks electronic patient record functionality and printing support. ONCO Assist, by contrast, is highly specialized, focusing on a single disease and limited functionality, with only a calculator available. Notably, it lacks support for features like a directory, podcasts, news updates, and medical consultations, making it less versatile compared to the other platforms. Updating a platform as the Cancer Treatment Protocol set (CTPS) system is a need to support doctors and manage their times. Selecting the appropriate developing platform will facilitate managing the information and set the current treatment regimens.

Flutter is a powerful and versatile software development kit (SDK) created by Google, enabling developers to build cross-platform applications efficiently. It supports the development of visually appealing and highly functional applications for mobile, web, and desktop platforms using a single, unified codebase. One of Flutter's key advantages is its capability for fast development, as it employs a feature known as "hot reload." This allows developers to instantly view updates and modifications in real time without the need for time-consuming rebuilding processes. Furthermore, Flutter offers a highly flexible and customizable user interface (UI), which empowers developers to create sophisticated designs that cater to diverse user requirements. Additionally, the integration of Agile methodologies into the software development process further enhances the efficiency of Flutter projects. Agile is a dynamic approach to software management, emphasizing iterative development and collaboration. It enables teams to adapt to changing requirements throughout the project lifecycle, ensuring a responsive and efficient workflow. This synergy between Flutter's fast, flexible development capabilities and the adaptability of Agile methodologies makes it a preferred choice for developers aiming to deliver high-quality applications within shorter timeframes[20].

This article represents a system designed to support tumor physicians in structuring comprehensive treatment plans. The CTPS features a database for managing and storing patient information. It assists physicians in selecting tailored treatment regimens (number of days, repeated cycle, dose per milligram) and subsequently describes the appropriate medication dosages, the treatment schedules, and offers recommendations based on the patient's specific condition. The system accommodates treatment protocols for seven different cancer types, including detailed chemotherapy dosage requirements for each stage of the treatment process.

The main contribution of this paper is the development of a mobile application supported by a cancer regimens database that allows doctors to initialize a personalized cancer treatment journey and specify the days, doses, and combinations within different treatment protocols. Additionally, patient information and treatment details are stored in the database.

2. Methods

Tumor physicians often spend significant time setting up treatment cycles for each patient. Automating setting the treatment regimens reduces time consumption and allows doctors to select the most suitable regimen from the available options on the CTPS mobile application. It is developed using Flutter, which leverages the Agile methodology to support development for both Android and iPhone Operating System (IOS) platforms. This mobile application provides several regimens for seven different cancer types, including breast cancer (invasive, nonmetastatic, recurrent, or metastatic), uterine sarcoma, thymomas, thymic carcinomas, soft tissue sarcomas, head cancer, and neck cancer.

2.1.Dataset Collection

The National Comprehensive Cancer Network (NCCN) is a nonprofit organization comprising 28 leading cancer centers dedicated to improving and facilitating access to high-quality, effective, and efficient cancer care, ultimately enhancing patients' quality of life [1]. The NCCN develops guidelines and protocols for cancer therapy, which are evidence-based and created by experts to provide recommendations for the diagnosis, treatment, and management of various cancers. These guidelines are widely recognized and utilized by oncologists and healthcare professionals globally to ensure standardized and high-quality cancer care. The NCCN Cancer Therapy Guidelines encompass several key aspects, including treatment protocols that provide detailed, step-by-step recommendations for managing specific cancers. These include approaches such as surgery, chemotherapy, radiation therapy, immunotherapy, and targeted therapies. The protocols are tailored to cancer types, stages, and patient-specific factors, such as age, performance status, and comorbidities. The guidelines also emphasize personalized medicine, integrating genomic testing and biomarker-driven approaches to create tailored treatment plans based on tumor-specific mutations. Additionally, they provide supportive care strategies to help manage symptoms and side effects such as pain, fatigue, and nausea, thereby improving the patient's overall quality of life during treatment. The NCCN Cancer Therapy Guidelines are an essential resource for standardizing cancer care, optimizing outcomes, and ensuring evidence-based oncology practices. These guidelines were referenced and utilized in developing our platform, with access to the recommendations gathered from their official resources [8]. This article depends on the guidelines to support decision-making to select the best course of action among several alternatives to achieve the desired outcome. The treatment doses are calculated dependent on the body surface area BSA.

$$BSA = \sqrt{\frac{Hight(cm) * Weight(kg)}{3{,}600}}$$

2.2. Application development

The development of the application was conducted using Dart, a programming language that is particularly optimized for client-side development, especially within the domain of mobile applications. Dart's integration with Flutter—a comprehensive and highly adaptable framework—facilitated the efficient development of cross-platform solutions through a unified codebase[21]. Flutter's advanced capabilities for rapid prototyping and seamless user interface design make it particularly suitable for addressing complex application requirements[22]. From a software engineering perspective, Flutter functions by employing a rendering engine that converts code into high-performance native interfaces across multiple platforms. The Flutter framework is built on the Skia graphics engine, which allows the creation of visually rich and fluid interfaces. The development process starts with writing Dart code, which establishes the application's architecture, business logic, and user interface[20, 23]. Flutter employs a widget-based architecture, where every component, ranging from simple buttons to complex layouts, is treated as a widget, as represented in figure 1. This modular, reusable approach to design promotes code maintainability and flexibility. Once the application code is implemented, Flutter's compilation process is initiated. Flutter supports two primary compilation strategies: Ahead-of-Time (AOT) and Just-in-Time (JIT). During the development phase, JIT compilation is used, enabling the "hot reload" feature that allows you to see changes in real time without restarting the entire application. This feature significantly accelerates the iterative design and testing cycle. For production builds, Flutter utilizes AOT compilation, which translates Dart code into native ARM machine code. This ensures superior performance by eliminating the overhead associated with runtime interpretation or dynamic compilation. The compiled code is then packaged into platform-specific containers. For Android, this involves generating an APK or AAB file, while for iOS, an IPA file is created. These packages encompass all necessary native binaries and resources, ensuring optimal performance across platform[21]. The combined use of Dart, Flutter, and Android Studio facilitated a methodologically rigorous and efficient development process, culminating in a mobile application that is both scalable and high performing.

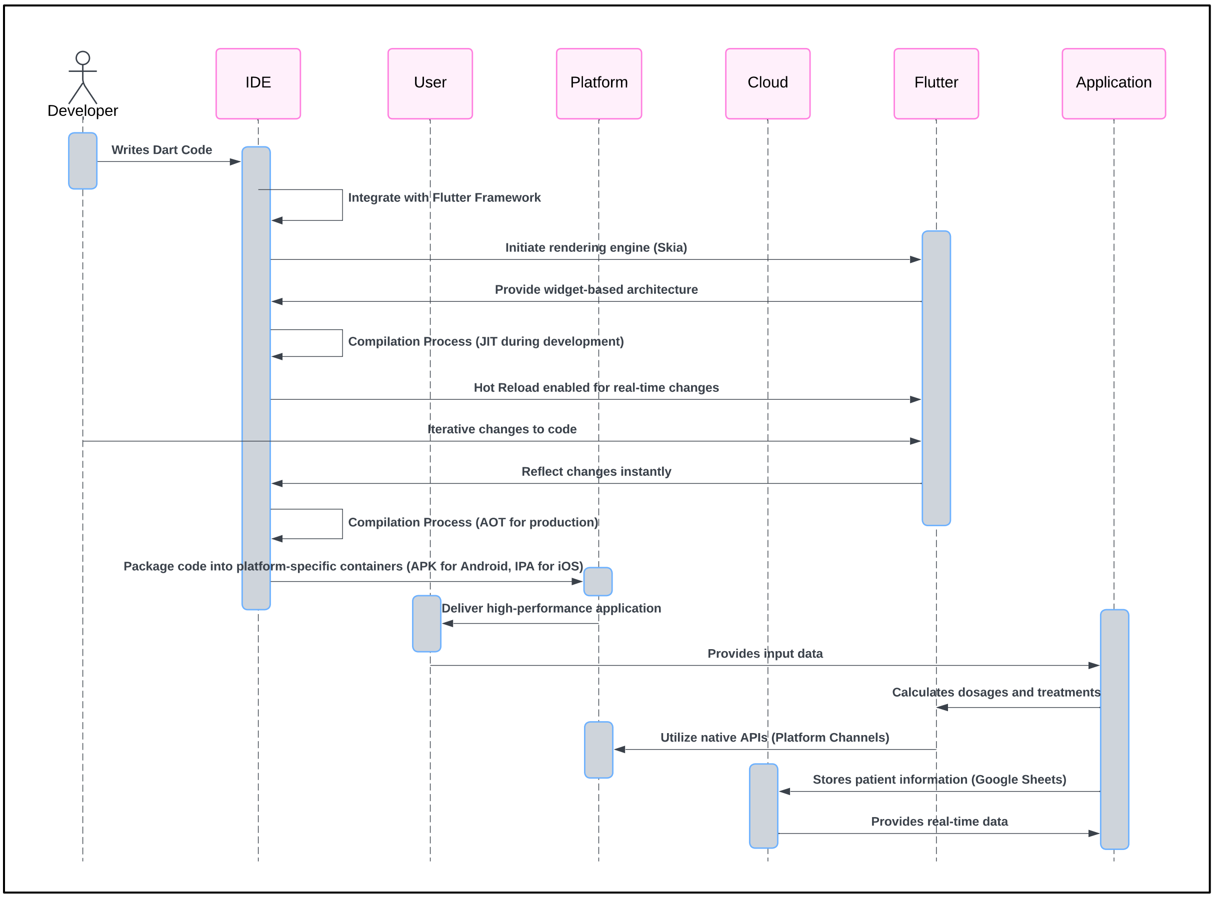


Fig.1: Sequence diagram for the CTPS development.

2.3. Application workflow

Figure 2 shows the workflow of the **CTPS** application; it works in the following steps:

Step 1: Application Initialization

Step 2: Enter the patients' information: (Inputs [High, Weight, Age, Gender, Name, and Cancer Grade, …])

Step 3: Record the patient information.

Step 4: Calculate body surface index.

Step 5: Select cancer type.

Step 6: Select the treatment protocol.

Step 7: Select the suitable regimen.

Step 8: Monitor the regimen dose according to the body surface area.

Step 9: Set the treatment journey.

Step 10: Save the patient's information and the treatment regimen in the database.

3. Results and Discussion

The main aim of this development application is to dedicate an accessible mobile application for the doctor to facilitate the exhausting daily work. Figure 3 displays the patient information entry screenshot. The image depicts a user input form designed to collect basic personal and health-related details, likely for a medical or health application. The form includes fields for entering the user's name, age, height (in centimeters), and weight (in kilograms). It also features gender selection buttons, represented by icons for male and female, as well as an option to choose a cancer grade ranging from 1 to 4, possibly using radio buttons. The design is minimalistic and user-friendly, with clear input prompts and a clean layout. The overall interface suggests a straightforward and intuitive user experience, suitable for health data collection or initial patient assessments. After entering the patient information and medical history, cancer type, and cancer stage. The program selects the suitable journey.

Figure 4 shows a CTPS interface for a user who has entered personal data with cancer grade of 2 to calculate their Body Surface Area (BSA). Thus indicates a classification relevant to medical assessment. The scientific measure often used in clinical settings to determine medication dosages, physiological norms, or treatment plans.

A dialog box with two options—"Change Values" and "Continue"—is presented, allowing the user to either modify the input data or proceed with the calculated results. This interface demonstrates an applied use of the BSA formula in personalized medical assessments.

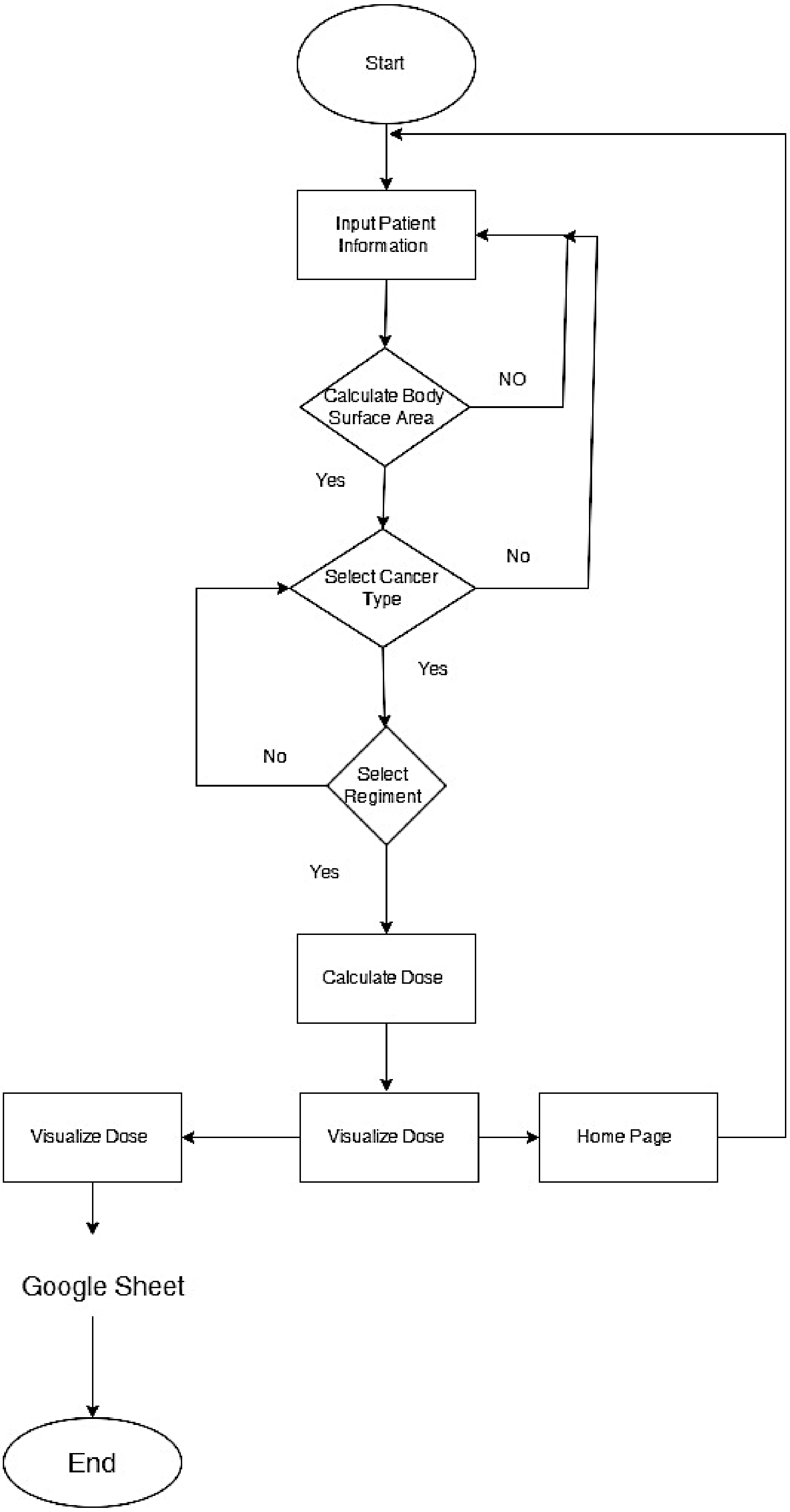


Fig. 2. A workflow for the **CTPS** application.

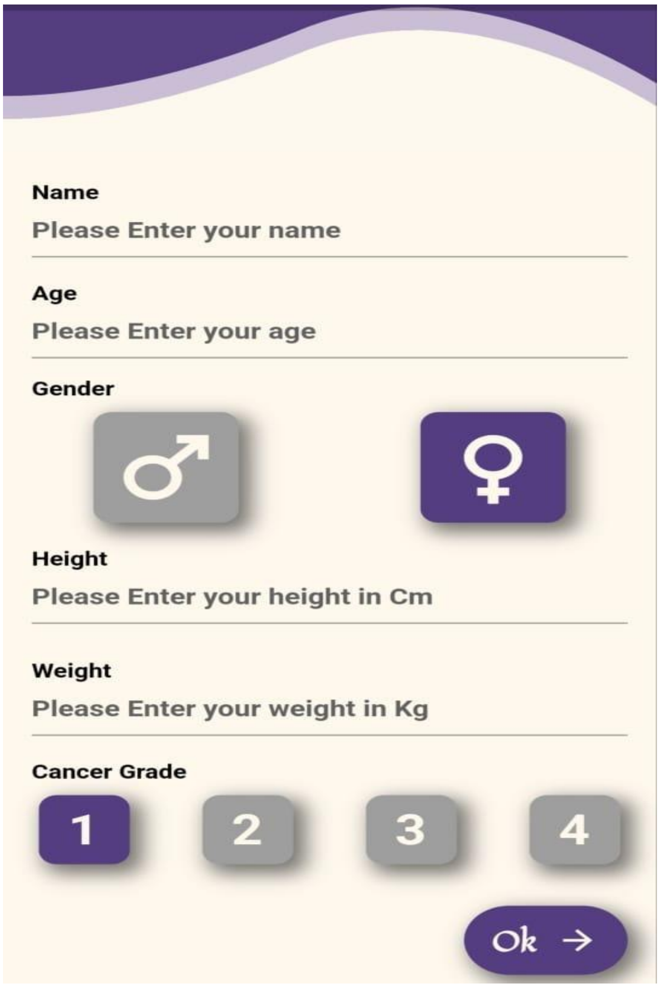


Fig 3: Screenshot of the patient entry information.

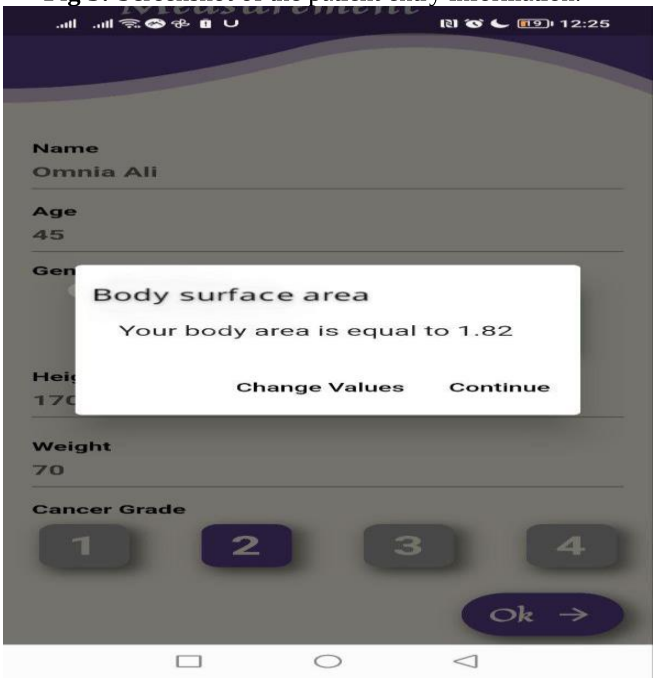


Fig 4. Screenshot of the calculating the body surface area.

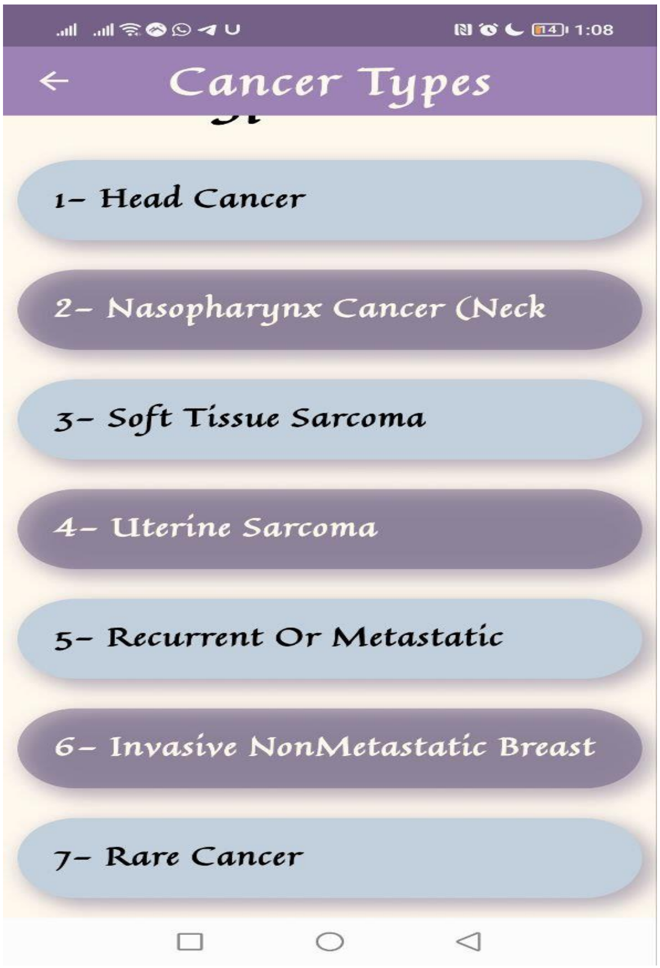


Fig 5. Screenshot of the different number of cancers.

Figure 5 displays a section of the health application dedicated to listing various cancer types. The list includes Head Cancer, Nasopharynx Cancer (Neck), Soft Tissue Sarcoma, Uterine Sarcoma, Recurrent or Metastatic Cancer, Invasive Non-Metastatic Breast Cancer, and Rare Cancer. This shot likely enables users to select a specific cancer type for further exploration, such as accessing detailed information, treatment options, or risk assessment tools. By organizing these categories clearly, the application facilitates ease of navigation and supports a targeted, personalized approach to addressing the diverse medical needs associated with different cancer types.

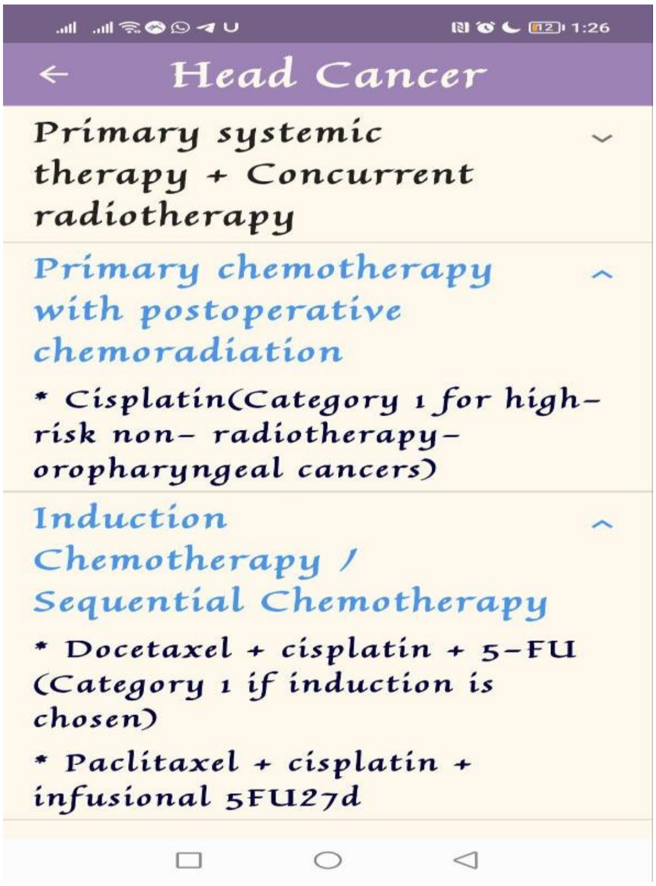
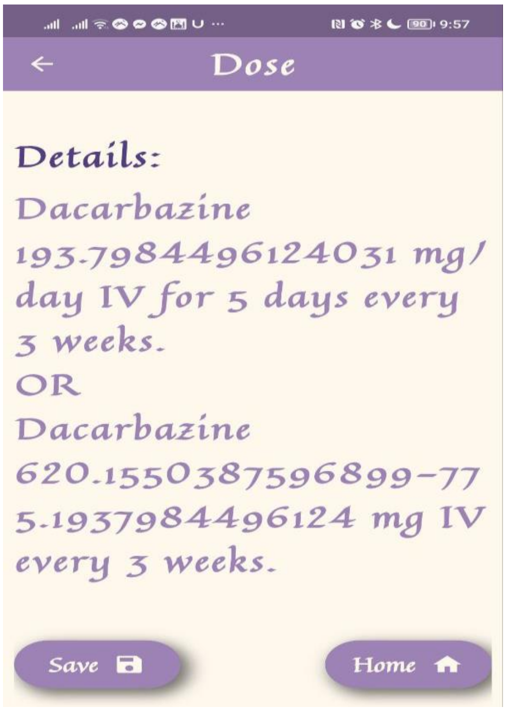


Fig 6. Screenshot of the different treatment protocols for head cancer.

Figure 6 outlines treatment options for head cancer, categorizing them into three primary strategies: Primary Systemic Therapy combined with Concurrent Radiotherapy, Primary Chemotherapy with Postoperative Chemoradiation, and Induction or Sequential Chemotherapy. The first approach combines systemic and radiotherapy treatments to enhance effectiveness. The second involves the use of cisplatin, identified as a Category 1 option for high-risk non-radiotherapy oropharyngeal cancers, applied postoperatively. The third option includes induction regimens such as Docetaxel + Cisplatin + 5-FU, categorized as a top choice if induction therapy is selected, and an alternative regimen of Paclitaxel + Cisplatin combined with continuous infusional 5-FU over 27 days. The structured layout provides clear, evidence-based therapeutic options tailored to specific clinical scenarios, supporting informed decision-making in the treatment of head cancer.

A



B

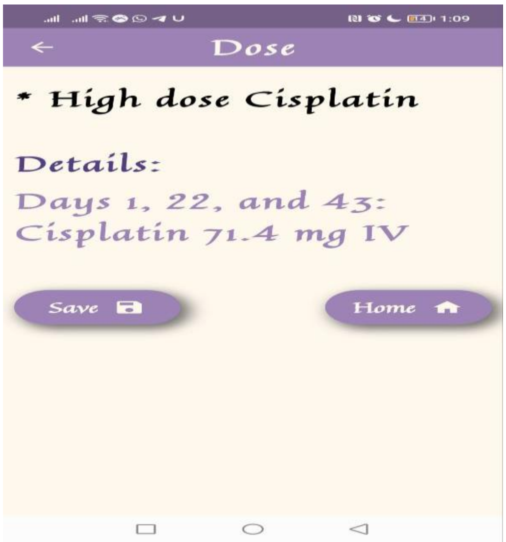
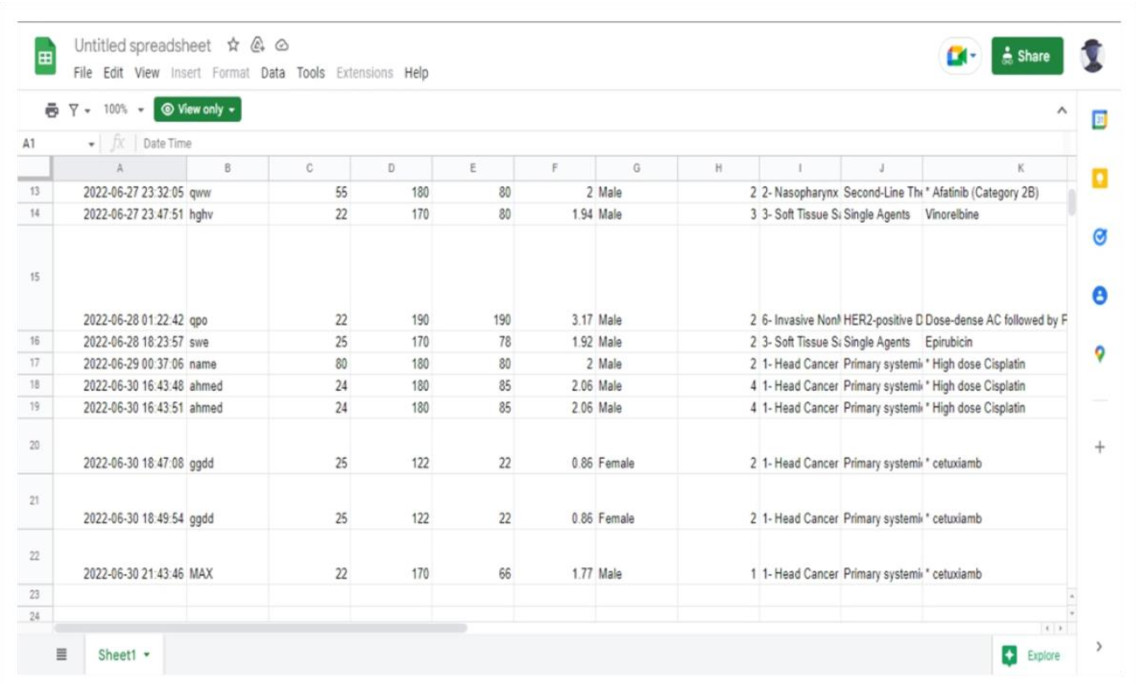


Fig 7. Screenshot of (A) the required dose according to the input information (B) the prescribed course of the medical treatment.

After the physician select the regimen, the treatment journey appeared as represented in figure 7 (A). The image outlines dosage details for the chemotherapy drug Dacarbazine, presenting two alternative intravenous (IV) regimens. The first option involves administering 193.798 mg/day for five consecutive days, repeated every three weeks. The second option prescribes a single dose of 620.155 mg, administered every three weeks. These precise dosages suggest they are calculated based on specific patient parameters to ensure personalized treatment. The inclusion of both regimens provides flexibility in treatment planning, depending on the patient's condition, tolerance, or specific protocol requirements. The interface also features "Save" and "Home" buttons, enabling users to store the prescribed dosage details or return to the main menu, ensuring clarity and ease of use for managing chemotherapy treatment plans.Another screenshot was represented in figure 7 (B) that provides dosage details for a high-dose cisplatin regimen. It specifies that 71.4 mg of cisplatin is to be administered intravenously (IV) on days 1, 22, and 43, indicating a planned schedule spaced over several weeks to optimize therapeutic effects while managing potential toxicity. The design of this schedule reflects a standard practice in oncology, where high-dose regimens are carefully timed to balance efficacy and patient recovery between doses. The interface also includes "Save" and "Home" buttons, offering functionality for saving the regimen details or returning to the main menu, ensuring the usability of the system for clinicians or patients managing chemotherapy protocols. The layout is clear and structured, providing concise information for precise and reliable treatment planning.



	A	B	C	D	E	F	G	H	I	J	K
13	2022-06-27 23:32:05	qww	55	180	80	2	Male	2	2- Nasopharynx	Second-Line Th	* Afatinib (Category 2B)
14	2022-06-27 23:47:51	hghv	22	170	80	1.94	Male	3	3- Soft Tissue S	Single Agents	Vinorelbine
15	2022-06-28 01:22:42	qpo	22	190	190	3.17	Male	2	6- Invasive Non	HER2-positive D	Dose-dense AC followed by F
16	2022-06-28 18:23:57	swe	25	170	78	1.92	Male	2	3- Soft Tissue S	Single Agents	Epirubicin
17	2022-06-29 00:37:06	name	80	180	80	2	Male	2	1- Head Cancer	Primary systemi	* High dose Cisplatin
18	2022-06-30 16:43:48	ahmed	24	180	85	2.06	Male	4	1- Head Cancer	Primary systemi	* High dose Cisplatin
19	2022-06-30 16:43:51	ahmed	24	180	85	2.06	Male	4	1- Head Cancer	Primary systemi	* High dose Cisplatin
20	2022-06-30 18:47:08	ggdd	25	122	22	0.86	Female	2	1- Head Cancer	Primary systemi	* cetuxiamb
21	2022-06-30 18:49:54	ggdd	25	122	22	0.86	Female	2	1- Head Cancer	Primary systemi	* cetuxiamb
22	2022-06-30 21:43:46	MAX	22	170	66	1.77	Male	1	1- Head Cancer	Primary systemi	* cetuxiamb
23											
24											

Fig 8. Screenshot of the saved information.

Finally, the patient's information is stored as shown in the Figure 8. The spreadsheet contains structured data documenting patient demographics, cancer types, and treatment protocols, likely for clinical or research purposes. It includes columns for the date and time of entry, patient names (potentially pseudonyms for privacy), age, height, weight, calculated body surface area (BSA), and gender. These parameters are essential for personalizing chemotherapy dosages. The data also details cancer types and grades, such as head cancer and soft tissue sarcoma, alongside specific treatment regimens, including high-dose cisplatin, vinorelbine, and targeted therapies. The spreadsheet shows patterns of treatment, with multiple patients undergoing similar protocols for specific cancers, reflecting its use in tracking and managing individualized therapies. This format allows for systematic monitoring of patient profiles, ensuring precision in treatment planning and aiding healthcare providers in evaluating the efficacy of therapeutic interventions. A structured feedback collection process will be implemented, involving oncologists and healthcare professionals during the development and testing phases. Usability testing sessions, surveys, and focus groups will be conducted to gather insights on the application's functionality, user interface, and workflow integration. The feedback obtained will be systematically analyzed, and iterative updates will be made to address identified challenges and improve overall user experience. This approach will ensure that the system aligns with the practical needs and expectations of its end-users, ultimately enhancing its adoption and effectiveness in clinical settings. and aiding healthcare providers in evaluating the efficacy of therapeutic interventions.

A high patient-to-doctor ratio often leads to longer working hours for doctors, leaving them feeling exhausted. Mobile applications that assist in calculating doses and regimens for numerous patients daily can serve as valuable tools during these extended workdays. In the application developed here, the doctor begins by entering the patient's information. The application then calculates the body surface area. If needed, the doctor can return to the personal information entry screen to update or re-enter the data. Next, the doctor navigates to a screen displaying different cancer types and selects the relevant type, followed by the appropriate regimen. For the chosen regimen, the doses for all medications are displayed. Upon pressing the save button, the data is securely stored in a Google Sheet in Excel format. This application stands out from others [18]by not only saving patient information but also enabling the doctor to track and manage regimens efficiently. The possibility of integrating the Cancer Treatment Protocol Set (CTPS) with Electronic Health Record (HER) platforms will be carefully explored to ensure seamless data synchronization and workflow optimization. By enabling interoperability between CTPS and EHR systems, manual data entry can be minimized, reducing the risk of errors and saving valuable time for healthcare providers. Additionally, patient data could be securely exchanged in real-time, enhancing the accuracy and efficiency of treatment planning. Future updates will prioritize compatibility with widely adopted EHR standards to ensure smooth integration across different healthcare environments.

In future, the database will be expanded to include additional cancer types and a broader range of patient demographics, ensuring greater adaptability and accuracy in treatment recommendations. Machine learning algorithms will also be incorporated to analyze historical patient data, enabling personalized treatment plans and predictive insights into patient-specific outcomes. Furthermore, longitudinal studies will be conducted to evaluate the long-term impact of the system on key metrics such as survival rates, recurrence rates, and overall quality of life. These enhancements are expected to refine the system’s capabilities, aligning it more closely with modern healthcare technologies and evidence-based medical practices. To ensure seamless adoption and effective utilization, a user training framework will be developed, including step-by-step tutorials, user manuals, and interactive workshops. Additionally, ongoing technical support will be provided through help desks, FAQ sections, and periodic webinars to address any challenges encountered during usage. These resources will be designed to streamline the onboarding process, enhance user confidence, and ensure optimal application performance in clinical settings. Additionally, regular training sessions and documentation will reinforce this principle, ensuring that healthcare providers are aware of the system’s intended purpose.

Plans are already in place to collaborate with healthcare institutions to conduct clinical validation studies, focusing on key performance indicators such as treatment accuracy, dosage precision, and patient outcomes. Data collected from these trials will offer concrete evidence of the system’s practical reliability and impact on clinical workflows. The insights gained will also guide further improvements to the system, ensuring it meets the highest medical and ethical standards.

It is recognized that while the application serves as a powerful tool for assisting in treatment planning, it is not intended to replace clinical judgment or the expertise of healthcare professionals. The system is designed to support decision-making by providing accurate dosage calculations, treatment schedules, and protocol recommendations, but final treatment decisions must always remain under the supervision of qualified physicians. Clear disclaimers and usage guidelines will be included within the application to emphasize its role as a decision-support tool rather than a replacement for medical expertise.

4. Conclusion

The increasing imbalance between the number of patients and available doctors has placed a significant burden on physicians, particularly tumor specialists who must consider numerous factors such as age, weight, gender, and medical history when devising treatment protocols. The Cancer Treatment Protocol Set (CTPS) system addresses this challenge by providing a streamlined solution for developing cancer treatment regimens. By incorporating a database for storing patient information and offering tools to calculate drug dosages and treatment schedules, CTPS simplifies the process of determining individualized treatment plans. Supporting protocols for seven cancer types, the system enables doctors to select from pre-configured regimens tailored to the patient's condition. Developed using the Flutter platform, CTPS uses input data and built-in equations to ensure accurate dosage calculations. Additionally, its integration with Google Sheets ensures that patient data and regimens are securely stored and easily accessible, making it an invaluable tool for improving efficiency and reducing the workload of healthcare professionals. This system represents a significant step forward in leveraging technology to support personalized and efficient cancer treatment planning.

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