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Integrated Telehealth Infrastructure for Ambulatory Stroke Pathway Tyrol

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Abstract. Background: The Integrated Treatment Pathway Stroke Tyrol was introduced for the care of people after an acute stroke event and includes four phases: acute prehospital care, inpatient treatment, inpatient rehabilitation and ambulatory, outpatient rehabilitation. For the 4th phase, the ambulatory rehabilitation of patients after discharge, the ICT platform "StrokeNet Tyrol" was established. Methods: Requirements and processes along the pathway and between the interdisciplinary team were taken into account for implementation based on a modular software architecture. Flexible rights and role concept was developed to support efficient collaboration of the heterogenic professions. Results: The routine usage of 342 users with 8 different roles, 2,219 registered patient cases within the last 4 years and first results of the integrated benchmarking solution give a positive impression regarding feasibility and effectiveness. Conclusion: To this point, a comprehensive infrastructure for the Ambulatory Tyrolean Stroke Pathway has been established. Results from outcome analyses and comparative studies could help to further improve usability and to expand the area of application for other indications.

Keywords. integrated health care systems, stroke, stroke rehabilitation, outpatient rehabilitation, patient care management, digital health, disease management programs

1. Introduction

Stroke is a major medical and health policy challenge in Austria. According to Statistics Austria, 4,532 people died with a stroke diagnosis (ICD10: I60-I69) [1] in 2021 - which is one of the most common causes of death in Austria. In addition, a stroke often results in physical disability in adulthood and promotes dementia and depression.

The most common type of stroke is ischemic stroke (cerebral infarction) due to a blood clot, which is treated by intravenous thrombolysis. Outcome is time dependent and treatment must be given within a time window of less than 4.5 hours after onset of

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symptoms [2]. The Stroke Action Plan of the European Stroke Organization (ESO) [3] includes the establishment of stroke pathways across Europe as a key objective. The goal and benefit of a stroke pathway is to ensure that as many affected individuals as possible benefit from acute intravenous thrombolysis therapy.

In a society with a growing proportion of chronically ill people, integrated care is becoming increasingly important. In addition to making more efficient use of existing resources such as nurses, healthcare providers (GSPs) and physicians, it primarily serves to promote cooperative collaboration among all healthcare stakeholders with the overarching goal of improving healthcare. Kodner et.al. already elaborated the meaning of integrated care in 2002 [4]. For him, the word "integrated" means "glue" that holds the various units together. Translated to the health care system, this figuratively means the implementation of models and methods of financing, administration, organization, service provision and clinical services to overcome sectoral boundaries so that cooperation, coordination and communication in health care become possible [5]. Due to technical developments in the field of digital health and the findings in the field of integrated care, treatment pathways and disease management programs (DMPs) for the coordinated, interdisciplinary and cross-sectoral care of people with certain diseases are becoming more and more common [6].

The Tyrolean Stroke Pathway has been implemented to optimize the entire treatment from stroke onset and acute care to outpatient stroke rehabilitation [2], and sets new standards in stroke therapy with collaborative, quality-controlled care close to home [7]. Tyrol is a federal state of Austria with 764,102 inhabitants in 2022. The integrated treatment pathway describes the processes and interfaces of the different treatment stages: 1) prehospital phase, 2) inpatient phase, 3) inpatient rehabilitation/acute aftercare and 4) outpatient rehabilitation) [8], [9]. At the beginning the activity was primarily focused on the stages one to three, however with the growing maturity of the pathway processes, the last stage – the post-discharge rehabilitation – became more important. The main challenges were to coordinate home-based rehabilitation with physio- and occupational therapy and logopedics, to start therapy as soon as possible after discharge and to provide a joint process-oriented documentation and communication service for all participating professionals and institutions including specialist for neurology and health insurance agencies for the approval and billing of therapy units.

To meet data protection and privacy requirements the system needed to support specific user permissions and user roles with dedicated role-specific data access. Depending on the process status, data access should be automatically enabled for different activities and blocked again after a process step is finished. Another requirement was the ability for automated benchmarking and outcome assessment.
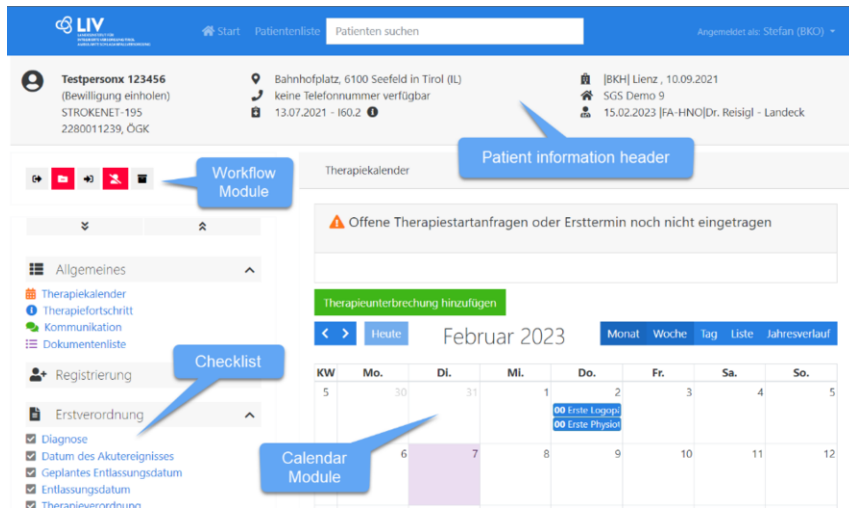
2. Methods

Figure 1. User dashboard of the StrokeNet system showing main components: patient information header, workflow module, checklist and calendar module

2.1. StrokeNet IT Infrastructure

In the course of implementation, the paper-based documentation was digitalized and an improvement in the documentation and communication processes was achieved [10]. The system, StrokeNet, has been continuously improved and enhanced since 2019. The user dashboard (Figure 1) was designed to provide a quick overview of the patients' therapy status and easy data collection for all user roles. The overall system framework (Figure 2) was designed with modular components and interfaces to existing service infrastructure. StrokeNet was implemented based on the KIT Telehealth Framework [10] (AIT Austrian Institute of Technology GmbH) and the Django web framework [11]. Access for system administrators and StrokeNet users can be provided with different permission controls via technically separate ports. Multiple security measures were implemented and multi-factor authentication was mandatory for all users. An e-mail server enabled e-mails to be sent to notify individual users about upcoming activities. For example, therapists were notified via email when a new therapy referral was received for a patient. In the future, these requests will also consider the therapists' workloads to allow therapy to begin as quickly as possible. For the purpose of anonymous benchmarking, a data normalization module was adopted using the Observational Medical Outcomes Partnership (OMOP) Common Data Model (CDM)[2] , so that key performance parameters are calculated on a daily basis and made available to the network coordinators. To provide health care providers with a fully closed documentation chain, a module for the creation of the billing data record for the Austrian health insurance agencies (ELDA data record[3], Österreichische Gesundheitskasse) was developed. The StrokeNet IT infrastructure is operated at the Tirol Kliniken[4] IT service center.

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[2] https://www.ohdsi.org/data-standardization/ , (last access: 07.02.2022)
[3] https://www.elda.at/cdscontent/?contentid=10007.838933 (last access: 17.03.2023)
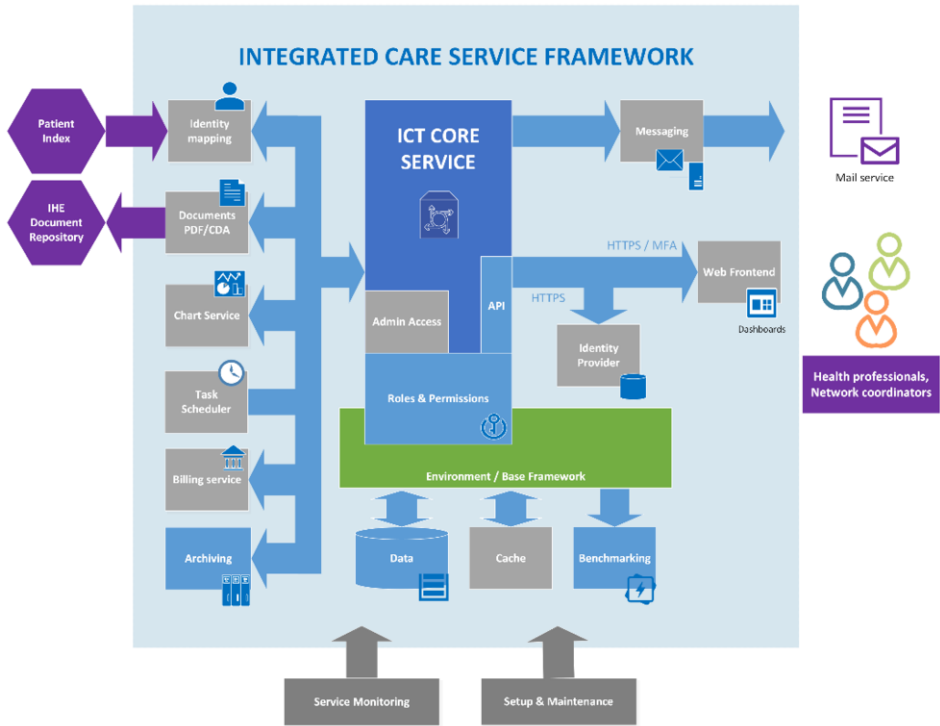[4] https://www.tirol-kliniken.at/ (last access: 17.03.2023)

Figure 2. Overall software architecture of the StrokeNet IT infrastructure.

2.2. Key functions of the system

For the day-to-day workflow, the contributory roles have an extensive functionality at their disposal. This functionality is described in the following key functions.

Table 1. Key functions of StrokeNet

Key function	Competence and responsibility
Forms	• Data entry forms for all common input data types (text, number, date, single- and multiple-choice lists) • Plausibility checks and visibility conditions
Document upload	• Drag & drop functionality for easy use • Validity checks • Sortable tables, chronologically ordered • Document properties
Therapy calendar	• Date of discharge from hospital • Therapy start requests for assigned therapists • Planned and performed therapy events and therapy breaks • 3-Month-Assessment • Color codes for clarity
Billing module	• Monthly billing record for one or multiple patients, separated for different health insurance institutes • Standardized record according to ELDA specification

Therapy goals and evaluation	• Individual collection of therapy goals for physio, occupational and logopedic therapy with multiple activity and functional goals • Evaluation of degree of coverage • Automated report generation for submission to health insurance and billing purposes
SINGER	• Specific data entry form for SINGER-Score ("Scores of independence for neurologic and geriatric rehabilitation" [12]). • Radar chart for visualization of the SINGER data. • Calculated and report generation
Therapy coordination	• Selection of nearest therapists with integrated Google Maps APIs (map, distance calculation) [13] • Request and assignment of therapists based on the initial therapy prescription • Notification and integrated communication for acceptance or rejection of requests depending on the therapist's current workload.
Notes module	• Easy accessible notes feature for interdisciplinary communication between therapists, coordinators and discharge managers
Patient list module	• Specific patient lists for user roles showing patient status (e.g. pending, in therapy, completed) • Filtering function (e.g. hospital, therapist, district) • Open tasks and next process step for responsible user group
Social security provider – Billing confirmation	• Access for health insurance institute to approve or reject submitted billing documents, provided by therapists • Approval/rejection feedback is provided to therapists concerned
Social security provider – Therapy prescription approval	• Access for social security providers to approve or reject uploaded and signed (by physician) therapy prescriptions • In both cases, a new version of the therapy prescription is automatically created and sent back to the network coordinator concerned
Workflow module	• Show current and next process steps • Various workflow actions buttons for all user roles

Notifications	• Event-triggered Email notifications e.g. for
	    ○ New therapy start request (sent to assigned therapists)
	    ○ New patient has been assigned (sent to network coordinator)
	    ○ Approval has been uploaded (sent to therapists)
	    ○ Billing record available (sent to social security providers)

Interactive patient menu	• Dynamic patient menu as "checklist" • Menu items with status "checked" (= data entered) or "unchecked" (= no data entered yet). • Customized checklist with main tasks for each user role
Benchmarking module	• Automatic anonymization of patient data for online statistical analysis • Integrated benchmarking dashboard for comparison of aggregated data at district level • Filters for time ranges and stored evaluations (number of days between discharge and first therapy, number of therapy appointments, etc.)

2.3. User Roles

According to the defined responsibilities of the contributors in the Stroke Path Tyrol, different user roles with corresponding data access rights were defined to perform relevant actions and tasks.

Table 2. Competences and responsibilities of StrokeNet user roles and number of users (#) in 2022

User role	Competence and responsibility	#
Discharge Management	• Registering patients in the system with home address • Data entry and document upload (informed consent, prescription, discharge letter, SINGER assessment, etc.)	37

	• Transferring patients from the inpatient setting to outpatient rehabilitation	
Network Coordinator	• Find therapists who can carry out the patient's therapy at home • Submit prescription for the therapy to the responsible health insurance for approval.	10
Therapist	• Define therapy goals and coordinate appointments • Carry out the patient's therapy with interdisciplinary coordination between the two or three relevant disciplines out of physio and/or occupational therapy and/or logopedics • Perform outcome assessment based on SINGER score • Compiling summary report and generate billing record	260
Consultant	• Neurologist in private practice • Carry out neurological assessment three months after the outpatient rehabilitation care	21
Health Insurance Agency	• Check and approve the therapy prescription • Check and approve billing record of the therapist	7
Rehabilitation center	• Patients admitted to inpatient facilities for rehabilitation have their therapy documented by center staff. • Users with this role have the option to register patient in the system in the same way as the discharge manager	7

3. Results

The routine support of the ambulatory stroke rehabilitation with the StrokeNet system started in 2019 by the IT service center of the Tyrol Clinics. Central coordination of the ambulatory stroke pathway is organized via the Tyrolean Federal Institute for Integrated Care[5]. Overall, 2,219 patients have been registered in the years 2019 (101), 2020 (612), 2021 (785) and 2022 (721).

The breakdown of all patients registered in 2022 over the 9 Tyrolean districts in relation to the number of inhabitants indicates a range of registrations per inhabitant of 0.06 % (20 cases) in district Reutte to 0.11 % (48 cases) in district Landeck with a mean value of 0.09 %. Compared to the mean incidence for stroke of 0.21% according to the Austrian Stroke Society[6] about 44 % of all strokes in Tyrol are treated along the ambulatory pathway.

Table 2 shows the number of different user roles with dedicated permissions and access rights. Overall, 342 individual professional system users were registered in the system. 260 of them are therapists, divided into physio therapists (124), occupational therapists (71) and logopedics (65). It is noteworthy that 76 % of all users are therapists, with physiotherapists in the majority.

Since the introduction of StrokeNet the hospital discharge management was able to centrally register patients transferred for ambulatory rehabilitation and to provide all relevant documents for all professional users and institutions involved. The need for extensive contact with regional offices associated with the patient's residence is no longer relevant, as communication and coordination were supported by the system.

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[5] LIV Landesinstitut für Integrierte Versorgung Tirol, https://www.liv.tirol/ (last access: 07.02.2023)

[6] Austrian Stroke Society, https://www.xn--gsf-rna.at/stroke-units/zahlen-und-fakten/ (last access: 07.02.2023)

A central task of the network coordinator is to find therapists for the outpatient rehabilitation. In the past this was done through extensive telephone contacts with several therapists until finally one therapist agreed to the rehabilitation of the patient. That time effort resulted in a noticeably delayed therapy start. With StrokeNet, the network coordinators are supported in finding and contacting a therapist in close proximity of the patients' home. If the therapist agrees to the patient's care with the help of the implemented workflow, the relevant network coordinator is informed and can continue the process within the system. This saves time and reduces administrative effort. **Table 3** shows initial results for the mean duration between day of discharge and first day of therapy which is one of the key performance indicators (KPI) that are available via the integrated benchmarking module. The numbers show that between 2019 and 2022 about 30 % of all patients received their first therapy within 7 days after discharge and in general more than 50 % received the first therapy within 14 days after discharge from hospital.

Table 3. Number of therapy units (#TU) started within 0-7, within 7-14 and after more than 14 days after discharge from hospital in the years 2019 to 2022

Days until 1st therapy	2019		2020		2021		2022	
	#TU	[%]	#TU	[%]	#TU	[%]	#TU	[%]
0-7 days	49	29.9 %	360	32.4 %	375	26.7 %	373	29.6 %
7-14 days	39	23.8 %	237	21.3 %	407	28.9 %	314	24.9 %
> 14 days	76	46.3 %	514	46.3 %	625	44.4 %	575	45.6 %
Total #TU	164		1,111		1,407		1,262	

4. Discussion

Outpatient rehabilitation of patients with stroke involves up to 3 different therapists simultaneously over a period of several months. Effective communication and information exchange between individuals are essential components for interdisciplinary collaboration. It is not only about providing relevant information for the organizational process steps, but also about enabling secure and uncomplicated information exchange between the therapy teams. The support of StrokeNet eliminates the need for complex and insecure communications on different communication channels.

The largest and most important part of the system is the support of the therapist. With this tool, therapists can plan, document and evaluate their work with the patient. It is a great benefit for therapists that the documented work is prepared in such a way that the relevant data for billing their services to the health insurance agencies can be directly submitted through the system.

The central coordination of the Tyrolean Stroke Pathway is organized by the LIV where personal resources with specific know-how and basic infrastructure for integrated care programs have been established. The main motivation and goal was to begin outpatient therapy in the patient's home within a few days of discharge from the hospital regardless of the patient's location. It must be mentioned that the requirements elicitation and technical implementation of StrokeNet took place in several steps and in close coordination with an interdisciplinary group of key users. The functioning cooperation with different professions and across institutional boundaries (transition from the intra- to the extramural sector) requires a structured and tight coordination. The effort required

to coordinate a large number of users, as is the case with StrokeNet, should not be underestimated. After all, even in the most remote valleys of Tyrol there is a network of therapists that needs support. Over time, requirements were supplemented by administrative functions like the possibility of simplified standardized billing for therapists.

The heterogeneous treatment and rehabilitation after strokes in Austria are based on structures due to federalism. Outpatient therapy within one's own four walls, as it is practiced in Tyrol, is thus classified as outcome-relevant, primarily because of the improved processes it entails [14]. In StrokeNet, too, basic care processes had to be rethought and have thus contributed to the improvement of the infrastructure. The automatic benchmarking of KPI enables a direct comparison between urban and rural care with the aim of achieving the same quality of care in a different structural starting situation. The stable numbers for the time between discharge and therapy initiation indicate that the transition has been well managed during the rollout from 2019 to 2022, with increasing patient cases. Existing limitations or disadvantages of StrokeNet are certainly the partly additional time-critical documentation and the coordination effort for the network. StrokeNet was designed to support a complex use case with many roles and workflows. Future enhancements should increasingly support intercommunication between existing digital systems (e.g. EHR, HIS) to avoid fragmentation of information. The billing and approval processes with and from health insurance agencies for therapists and patients still represent an existing administrative hurdle for smooth functioning of integrated care. Although evaluation data are not available, the experience during the COVID-19 pandemic shows that the enormous burdens were both a barrier and a motivation for the use of digital health platforms for integrated care.

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