



Virtual Fracture Care

Direct Discharge of isolated, stable, musculoskeletal injuries. Is once enough?

This article describes the patient and healthcare professional perspective with Direct Discharge, which discharges patients with isolated, low-complex musculoskeletal injuries from the Emergency Department and assists them with a smartphone application and a brace or sling. These findings show that Direct Discharge is perceived as a feasible, satisfactory, and safe alternative to traditional treatment with a cast and routine outpatient follow-up, but sometimes requires personal nuances.

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Maintaining high-quality orthopedic trauma care is becoming a challenge due to an increase in the incidence of bone fractures and a lack of qualified personnel. To address this increase, hospitals in the United Kingdom (UK) developed Direct Discharge (DD), which is currently standard-of-care in over 80 UK hospitals (Jenkins et al., 2014). DD concerns patients with isolated, stable musculoskeletal injuries, which recover well with limited immobilization. Traditionally, such patients attended at least one outpatient follow-up appointment. Alternatively, with DD, they are discharged directly from the Emergency Department (ED), and receive removable immobilization instead of a cast, an informative brochure, and a telephone helpline for any inquiries during recovery. Prior studies demonstrated significant reductions in secondary healthcare utilization (i.e., outpatient follow-up and imaging) (SHU), without negatively affecting functional outcomes, patient satisfaction, or complications (Khan et al., 2020). Nevertheless, evidence on DD's feasibility from a patients' perspective, healthcare professional's perspective is lacking, leading to a discrepancy between the UK guidelines and practice.

Inspired by the UK's success, OLVG Hospital adapted DD to the Dutch healthcare system, including twelve isolated, stable musculoskeletal injuries, and adding a self-care smartphone application called 'the Virtual Fracture Care app' to support patients during recovery (Figure 1) (Geerdink et al., 2020). The adoption of DD has accelerated during the COVID-19 measures, due to social distancing, and has led to implementation in thirty Dutch hospitals. This quick adoption may cause discrepancy between Dutch guidelines and practice, similar to the UK setting. Therefore, experiences from

both the patient and healthcare perspective are essential to establish prerequisites for the durable adoption of DD. The accelerated adoption of DD presented a unique opportunity to gather these experiences within various hospitals. Recognizing this, ZonMw, the Netherlands Organization for Health Research and Development, provided an unrestricted grant to execute these studies.

These studies aimed to gather prerequisite knowledge for the successful implementation of DD as a standard alternative to face-to-face care in three hospitals.

Method

Design

Two mixed-method studies were performed between August 2021 and July 2022 alongside the implementation of DD in three teaching hospitals, treating between 1200 and 1800 DD patients annually per hospital. Both studies, including the process analysis, were ethically reviewed and approved by the Medical Ethical Committee of Utrecht, Netherlands (W21.261).

Traditional treatment

Before DD implementation, healthcare professionals treated patients according to local trauma protocols. These protocols consisted of support with a cast, sling, bandage, or splint and brief injury-related information at the Emergency Department (ED). Follow-up schemes for these injuries vary per hospital in the Netherlands. However, at least one outpatient follow-up appointment was scheduled in the outpatient clinic within two weeks after the injury for review, extensive information, and definitive management planning.

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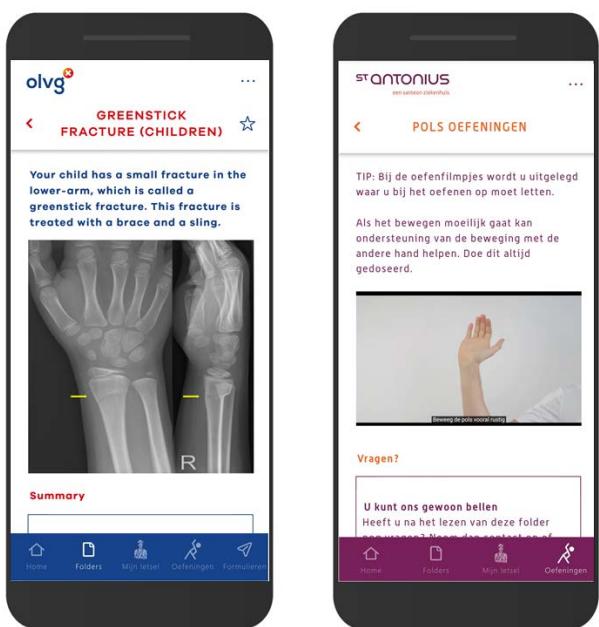


Figure 1. English and Dutch in-app screenshots of the Virtual Fracture Care app used in the Direct Discharge protocol.

Direct Discharge protocol

The Dutch version of DD included Dutch or English-speaking patients with isolated, stable musculoskeletal injuries with additional injury-related criteria (Geerdink et al., 2020). Patients were not treated with DD if they had initial treatment or follow-up in a hospital not involved in the study, multiple injuries, social care reasons (e.g., intellectual disability), or altered mental state during the ED visit. With DD, patients were discharged directly from the ED without routine outpatient follow-up, received a removable orthosis or sling, and comprehensive information at the ED, summarized in the Virtual Fracture Care app (VFC). Physical follow-up was scheduled if deemed necessary by the ED staff. As a safety net, all decisions and x-rays were re-evaluated by a multidisciplinary team supervised by a trauma surgeon the next workday, and patients were rescheduled for follow-up if necessary.

Virtual Fracture Care Application

The VFC app offered self-care assistance through injury-specific leaflets with recovery information, treatment rules, red flags, frequently asked questions, audiovisual exercise-, immobilization- and analgesic instructions. Additionally, the app included a telephone helpline operated by a healthcare professional during working hours for any injury-related inquiries.

Mixed-method study among patients

To collect patient experiences, a mixed-method study was conducted at three hospitals during DD implementation. In- and exclusion criteria for this study were identical to the criteria for DD. Eligible patients or parents (if patients were below 16 years)

were asked to download the VFC app at the ED and consent to the study. Data were collected through a survey immediately after the ED visit to gather DD-expectations, and one three months post-injury collecting DD-experiences, and semi-structured interviews were performed in a sample. A purposive sample was selected based on age, sex, type of injury, and hospital for interviews six weeks post-injury. The research team developed the surveys and topic list. Quantitative and qualitative data were collected and analyzed separately by different teams. The Bowen feasibility framework organized data into the parameters: implementation, acceptation, preliminary efficacy, applicability, and demand. Satisfaction was measured on a 10-point scale varying from 1, meaning very dissatisfied to 10 very satisfied. 5-point Likert Scales were used to assess feasibility statements with 1 meaning, completely not and 5 meaning completely. Data triangulation was performed to present data per feasibility parameter and identify (dis)similarities.

Mixed-method study among healthcare professionals

To collect experiences of healthcare professionals involved in the daily clinical care for DD patients, a mixed-method study was performed in the same hospitals. These participants ranged from ED nurses to trauma surgeons. Healthcare professionals were contacted by e-mail to participate in a pre-implementation, post-implementation survey, and semi-structured interview. Frameworks, data handling, and analysis were identical to the mixed-method study among patients.

Results

Mixed-method study among patients

In total, 138 patients completed both surveys, and 18 semi-structured interviews were conducted. Most patients are women (60%), native Dutch speakers (98%), attended Dutch primary schools (98%), and had a minimum of a bachelor's degree (59%). Patients had a median age of 50 years.

Patients are satisfied with the introduction of DD at the ED. Some mention the hectic ED environment and difficulty downloading the app due to poor Wi-Fi connection. The in-app information after the ED visit is beneficial, as the physiological distress and the hectic ED environment limited information recollection. Patients report a median satisfaction with treatment of 7.8 (IQR 6.6 to 8.8). Enhanced treatment engagement is reported in 58 (42%) patients, caused by increased self-empowerment in 67 (49%) patients. Patients prefer the removable orthosis over a cast because it is lighter and less rigid than a cast, leading to better mobility. Nevertheless, patients mentioned it could also lead to over-exertion due to the smaller size of the brace and decreased perceived injury severity.



		Traditional treatment protocol		Direct Discharge protocol	
Timing	Location	Occupation and tasks	Location	Occupation and tasks	
Day 0 to 1	ED [^]	 Resident / ED physician  Diagnose and inform  Plaster technician / dedicated ED nurse  Apply cast  (orthopedic) trauma surgeon  Supervise, indication check <24 hrs*	 ED [^]	 Resident / ED Physician  Diagnose and inform  All ED nurses  Apply brace  (orthopedic) trauma surgeon  Supervise, indication check <24 hrs*	
Day 7 to 14	Plaster room	 Resident  Follow-up and inform  Plaster technician  Remove cast and (apply cast)  (orthopedic) trauma surgeon  Supervision	 Home  App	 Patient  Self-care, exercises  Plaster technician  Answer helpline	
Day 14 to 90	Plaster room	Variable Depending on required follow-up	 Plaster room	 Plaster technician  Answer helpline, follow-up	
 Change in task and/or occupation  Per indication  Emergency Department  Hours					

Figure 2. Treatment protocols before and after implementation of Direct Discharge and changes in location, involved stakeholders and tasks in daily care.

Most patients (68%) perceive DD as safe, but a few report a lack of reassurance. They propose implementing a feedback system with pain scores or communication tools.

Most patients consider the helpline important (138, 84%) as it provides a sense of security (62%). Some patients expect that they would require more assistance, if injuries are more severe than DD injuries. SHU was low (5%), and two patients re-attended the ED after discharge due to anxiety or pain at the fracture site and were scheduled for outpatient follow-up.

Almost all patients (95%) used the VFC app during recovery, primarily in the first week post-injury to check recovery exercises and phase, treatment and analgesic rules, and the helpline. Parents consult the app more than children and occasionally show it to their child, particularly when it contains visual content. Most patients prefer DD over face-to-face follow-up, highlighting the timesaving advantage.

Mixed-method study among healthcare professionals

Of the 217 eligible healthcare professionals, 124 started the primary survey, with 37 completing both. Additionally, 15 participated in semi-structured interviews. The respondents are 23 females (62%), with a median age of 38 (IQR 32 to 45). Their occupations include medical specialist (38%), resident (38%), plaster technician (19%), and ED nurse (5%).

Most consider DD as safe (73%) and a satisfactory alternative (median rating 7.8, IQR 6.8 to 8.9) to traditional treatment providing similar quality of care (82%). They believe DD leads to decreased SHU and hospital use (e.g., building and parking lot) (37; 73%). Although introducing DD requires more (explanation) time for residents and ED-physicians at the ED, the logistical benefits (i.e., SHU) outweigh this slight increase in time. To improve DD implementation, adequate schooling and early involvement of healthcare professionals in new tasks should be optimized. Some nurses report difficulty applying the braces due to sub-optimal or delayed schooling. Participants report that DD offers advantages like uniform, on-demand, and adequate information. However, DD also has disadvantages, such as reduced personal human attention, limited language options, and less suitability for those with poor digital literacy. The daily multidisciplinary radiologic evaluation and helpline are considered effective safety nets. In-app feedback like pain scores or surveys are proposed to address personal concerns about patient recovery. The lack of follow-up introduces more explanatory behavior from some (often inexperienced) residents at the ED. However, crowding could also lead to rushed app delivery to cope with high patient volumes.

After implementation, all professionals intend to continue using DD due to its efficiency, patient empowerment, and self-management benefits. The

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Table 1. Summary of prerequisites during all phases for the Direct Discharge protocol a substitute to face-to-face care for patients with isolated, stable musculoskeletal injuries.

Pillar	Themes	Prerequisites
Demand	Usefulness	The application should be a solution for a work and/or patient-perceived problem.
Preliminary efficacy	Quality of care	The perceived quality of care with the new (digitally assisted) protocol should be non-inferior to the previous protocol.
	Perceived safety	A safety net is necessary and should be available during the hours described in the digital solution.
Applicability	Accessibility	The digital solution is available and free of charge through the most used databases (e.g., Play Store or iOS app store).
	Workload	The digital solution should not lead to an increase of workload for healthcare professionals.

COVID-pandemic strengthened these beliefs, and positively influenced perceptions of eHealth. Integrating DD into daily activities varies among healthcare professionals. Orthopedic trauma surgeons experience decreased SHU and workload, leading to increased job satisfaction. In contrast, plaster technicians lose a satisfactory part of their job and mention that treating fewer low-complex injuries negatively affects their job satisfaction (Figure 2).

Discussion

Conclusion

Both mixed-method studies show that patients and healthcare professionals consider DD a feasible, satisfactory, and safe alternative to traditional treatment. These studies show that, according to healthcare professionals, one visit is enough for most patients with isolated, stable musculoskeletal injuries, but not for all. Therefore, attention should be paid to personal nuances, preferences, and safety nets to maintain optimal individual care. For healthcare professionals, DD reduces SHU, which helps to cope with strained resources. This reduction can influence job satisfaction both positively and negatively. Already high satisfaction rates can be enhanced by the early involvement of healthcare professionals with new tasks and developing numerical in-app patient feedback systems such as pain scores or communication tools.

Comparison with literature

Patient satisfaction and perceived safety with DD aligned with previous studies, emphasizing the value of additional visual and written information in the chaotic ED environment and psychological distress (Geerdink et al., 2020). Understanding the injury is crucial to follow self-care protocols and recognizing red flags adequately. Preliminary efficacy results were consistent with previous research, while the quality of care, number of complications, quality of information, and treatment satisfaction remained similarly high, SHU decreased (Kahn et al., 2020). Most patients preferred the VFC app over face-to-face follow-up. The use of

apps is not new in (orthopedic) trauma surgery, but adding a self-care application to DD is a novel approach. Patients and healthcare professionals acknowledged the safety of DD, appreciating the timesaving benefits. Nevertheless, some patients would prefer face-to-face interaction if injuries were more severe than DD injuries. A hybrid form of physical and digital care could be successful in these cases. Though the introduction of DD at the ED increased treatment time for some, almost all healthcare professionals reported that the benefits of DD (e.g., less SHU) outweighed this downside. This contrasts with the numerously reported barrier 'eHealth increases time' (Schreiweis et al., 2019). Although feasible, it should be noted that DD may not be suitable for those with low digital literacy, potentially exacerbating existing health disparities in an already digitally-oriented world. Patients' information demand and app usage varied, with a minority desiring contact that is more human. To address this, an in-app numerical feedback system was suggested, like a questionnaire or communication tool. Nonetheless, adding such systems would require a more enhanced application that complies with current laws and regulations for data storage.

Healthcare professionals saw DD as a response to the public demand for more efficient outpatient care, especially in an era of scarce resources. The willingness to continue using DD after implementation mirrored findings from other countries, indicating its widespread acceptance and applicability. The varying applicability of DD among stakeholders depended on changes in tasks and experiences after implementation, emphasizing the importance of early stakeholder involvement during the process, as highlighted in a related study (Logishetty, 2017).

Strengths and limitations

This study's strengths include the multidisciplinary approach to collecting, analyzing, and reporting qualitative and quantitative data, providing a valuable, organized, and realistic representation of DDs' human factors from a patient and healthcare professional perspective.



Limitations include the poor response rate among healthcare professionals, potential responder- and selection bias due to a younger, more native Dutch, and higher educated sample compared to the Dutch population, potentially limiting generalizability. Another limitation is that the ED nurses were not included initially but were added to the qualitative data during the study.

Evaluation of this study on human factors criteria

These studies add to the domain of human factors by describing the factors for implementing DD in the Dutch healthcare system. We assessed the views of different stakeholders, i.e. patients and healthcare professionals, on DD's impact on multiple feasibility parameters, such as implementation, acceptance, preliminary efficacy, demand and applicability. DD is a feasible solution to cope with scarce resources from a patient and healthcare professional perspective. This feasibility is also recognized by the 30 Dutch hospitals that have implemented DD as the standard of care since 2019. Both study results and implementation experiences have led to general preconditions for self-care applications (Table 1 and Appendix A). Early stakeholder involvement for healthcare professionals with new tasks and numerical feedback, such as pain scores, could be implemented to further improve DD.



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APPENDIX A

Table A. Predefined prerequisites during the design phase for the Direct Discharge protocol as a substitute to face-to-face care for patients with isolated, stable musculoskeletal injuries.

Pillar	Themes	Prerequisites
Implementation	Stakeholder involvement	The new protocol is tested prior to the primary implementation with all relevant stakeholders.
Acceptation	Satisfaction	The new protocol has similar patient satisfaction with treatment scores compared to the previous protocol.
Preliminary efficacy	Functional outcomes	The new protocol leads to similar functional outcomes of patients compared with the previous protocol. The new protocol leads at least to similar complication rates as the previous protocol.
	Secondary Healthcare Utilization	The new protocol leads to a reduction of outpatient follow-up. The new protocol leads to a reduction of imaging.
	Primary Healthcare Utilization	The new protocol does not lead to an increase of general practitioner appointments compared to the protocol. The new protocol does not result in an increase of physiotherapy appointments compared to the protocol.
	Safety	The new protocol has a safety net to reassess patient inclusion by a more senior doctor. The new protocol has clear risk factors, outcome measures, and red flags to describe the injury-related inclusion criteria for the included injuries. The new protocol has patient-related demographic risk factors to describe the patient-related inclusion criteria for the target population. The new protocol has a safety net to contact the hospital outside of the digital solution.
Applicability	Workload	The new protocol does not result in a substantial increase of working activities for each healthcare professional.
	Accessibility	The new digital tool is accessible and free of charge through the most used databases for digital tools (e.g., Play Store or iOS app store). The new protocol (with digital assistance) complies with current (and expected changes in) laws and regulations.
Demand	Usefulness	The new protocol should be a solution for a perceived work problem compared to the previous protocol.

Table B. Prerequisites for self-care applications in orthopedic- and trauma surgery from a patient perspective based on the results with the Direct Discharge protocol.

Pillar (theme)	Prerequisites	Quotes
Implementation	Introduction should include information about correct use, the injury, normal recovery, and red flags.	<i>"Because... it always goes quickly. It is always busy. But still, you know, this was completely clear; what I could expect and that I could download the app."</i>
Acceptation	The new protocol should be a good fit for most patients, preferably all. The new protocol should be non-inferior to the previous protocol in terms of satisfaction. A safety net is necessary and should be available during the hours described in the digital solution. Direct Discharge is a satisfactory solution for low-complex injuries, perhaps not for more severe injuries Self-empowerment and self-management should be included in the evaluation phase.	<i>"I would give DD a 7 or 8. Yeah, let's say 7, because I do feel that it might be difficult for older people. Especially because they don't always understand technology, you know."</i> <i>"To be honest, I think it's better. You know, often it's like, you go to a hospital, and it takes half a day just to get there, and come back, and all those things, and then it's just like: "O, it looks fine".</i> <i>"After about a week or three, I had a setback. I couldn't find this in the app, so I decided to call the helpline. The pain came back, and I was afraid I had broken something or something like that. They reassured me that it could not happen so quickly and that I just needed to rest for 24 hours. They were right! It was nice to be able to check this."</i> <i>"Yes, I believe it is safe, given the circumstances. Because it wasn't that serious. Yes. I do have the confidence that if it is something serious I would not receive this type of treatment."</i> <i>"It was nice that I could read what I was allowed to do and what I was not. I think that gave me more control over my recovery. I knew what I could do myself in terms of exercises, and that was very helpful."</i>
Preliminary efficacy	none	none
Demand	none	none



Table C. Prerequisites for self-care applications in orthopedic- and trauma surgery from healthcare professional perspective based on the results with the Direct Discharge protocol.

Pillar	Prerequisites	Quotes
Implementation	Schooling during implementation is essential to correctly execute the protocol, particularly among healthcare professionals with new tasks.	<i>"Some of my colleagues have difficulty with the materials. How does it work and what goes where? It takes a bit longer for some of them to get the hang of it. Having to learn so many new things sometimes causes resistance."</i>
Acceptation	Scientific evidence of the efficacy supports the protocol in terms of perceived safety and satisfaction The digital application should be (assisting) a solution for a work problem.	<i>"I think DD is safe, but we are not sure yet. If we know it is safe for our patients I would be fully satisfied."</i> <i>"I no longer have to do these routine outpatient clinic check-ups. I could only provide limited contributions besides providing information, allowing me to have more time and space in the clinic. I can use that time for other patients to add more value."</i>
	The digital solution should not lead to an increase of workload for healthcare professionals.	<i>"Both among doctors and nurses, DD has been widely embraced and well implemented, but for both professions, it requires valuable extra minutes due to additional explanation. Currently, the workload is very high."</i>
Preliminary efficacy	The application should be a solution for a work problem, in this case strained resources. The quality of care with the new protocol should be non-inferior to the previous protocol. The digital solution should not lead to an increase of workload for healthcare professionals.	<i>"We now have a tool in our hands to change healthcare without it deteriorating, which convinces people who tended towards over-treatment."</i> <i>"The quality is not affected, assuming the doctor was already good. It is mainly more efficient. Information provision has improved. It has become more modern. I think DD is not worse, but we're not certain yet."</i> <i>"We are sometimes called about 2-3 times per day on the fracture line. I don't think that's a bad score."</i>
Demand	The application should be a solution for a work problem, in this case strained resources. The application should be a solution for a work problem, in this case strained resources. The application should be a solution for a work problem, in this case strained resources.	<i>"Every day, a few patients are treated through the app. I am starting to notice the reduction in daily practice!"</i> <i>"In my work, it has changed that we see less patients, but new things have also been added. However, we no longer see minor injuries. The easier type of care has decreased a bit."</i> <i>"This is a significant improvement for the patients and appeals to their autonomy and control, as well as their own influence on the healing process. I believe it is motivating and in line with the current times."</i>

Table D. Lessons learned throughout the process from implementation to upscaling.

Pillar	Theme	Prerequisites
Implementation	Upscaling and information Point of contact	An application guide can positively attribute to the speed and level of adoption during upscaling of a concept. One main point of contact with medical knowledge and management skills can attribute to the findability, troubleshooting during problems, and general overview during upscaling. This does not have to be a medical specialist, but can also be a nurse.
(preliminary) efficacy	Scientific evidence as support Local evidence Monitoring data	Scientific evidence helps convince pragmatists, conservatives and skeptics. Even after sufficient scientific evidence, the option to monitor patients at a local level can attribute to the implementation as it can be used to increase perceived safety or for management evaluation. A central point of data collection can be a valuable addition for time-efficient monitoring of the data and outcomes of the protocol, as more stakeholders are involved
Applicability	Investments (time and financial) Law and regulation	Communicate the duration and financial investment with the interested hospitals so preparations can be made. Communicate that law and regulatory departments should complete processes prior to the implementation
Feasibility	Evaluation	Monitor the protocol in a regularly central meeting with one representative per hospital