Overdose Detection Alert and Responder Technology (ODART) Project

Final Report

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1. Introduction

Globally, there were an estimated 167,000 deaths related to drug use disorders in 2017 (UNODC, 2021), with opioids accounting for about two-thirds of these deaths. Countries in North America and Northern Europe have particularly high rates of drug overdoses (EMCDDA, 2021).

Scotland has the most severe Drug-Related Deaths (DRD) problem in Europe, almost four times the number of DRD in the EU. There were 1330 deaths in 2021 connected to people in vulnerable communities who use unregulated street drugs. Each death is a personal tragedy for them, their friends and families, and their communities. And many of them are preventable.

Deaths from drug overdoses can be prevented if acted upon quickly. Administering naloxone, an opioid antagonist, to a person suffering from an opioid overdose is a highly effective life-saving intervention if carried out in time. Therefore, the development of technologies to detect an overdose and alert first responders is of crucial importance.

In 2019 Prof Catriona Matheson reported, in a scoping review for Aberdeen City Alcohol and Drug Partnership (ADP), the available and emerging technological solutions that could help address DRD in Scotland. Findings were presented at a meeting of senior stakeholders, facilitated by the Drugs Research Network for Scotland (DRNS). This scoping work identified several technological solutions developed internationally and in Scotland, that could help reduce drug-related deaths and are worthy of further exploration and testing in the Scottish context.

In October 2020, the DRNS secured funding from the Scottish Government Digital Health and Care Directorate Scottish Government's Technology Enabled Care (TEC) Program and the ODART was launched in February 2021. The ODART programme, is a partnership between the University of Stirling and St Andrews University and is supported by the Digital Lifelines Scotland and the DRNS.

This is a final summary report on the ODART programme focussing on impact and subsequent initiatives. A previous report covered the review of devices and technologies available. This is available on the ODART website [https://odart.stir.ac.uk].

2. ODART Programme Aims

The ODART programme aimed to undertake scoping activities to progress the development, testing, review and roll-out of technological solutions to reduce overdose and drug-related deaths in Scotland. The project was closely connected to the Drug Deaths Taskforce (DDTF) and the Drugs Research Network for Scotland (DRNS) through mutual concerns to develop the evidence base regarding the use of technology to reduce DRD.

The ODART programme focussed on four main workstreams:

1. Remote overdose detection through wearables and sensors
2. Overdose First Responder applications
3. Community provision of naloxone boxes
4. Remote addiction consultations.

3. Recap of Report One

The aim of first report was to understand the problems regarding drug overdoses and scope out and assess the existing technologies developed for preventing drugs overdose death. This report focused on workstreams 1 and 2.

In this report we conducted a gap analysis of Scottish needs. Based on the analysis of the current situation, our report addresses four key challenges:

1- Overdosing when alone;
2- Access to naloxone in an emergency;
3- Knowledge gap;
4- Access to communities and support.

This report proposed that digital technologies could help to address the above mentioned challenges. It identified two main groups of digital technologies that can prevent fatal OD: 1. Sensor-based technologies that detect physiological signs of OD and prompt an alert; and 2. Smartphone applications that increase the chances of a timely response to OD.

For the sensor technologies, it identified and selected a total of 27 devices. It identified 20 devices that are specifically designed to respond to drug overdoses or are being, or were recently adapted, for this purpose. The different technologies are in different stages of development, from being only prototypes currently being used in the real world. Ten products are actively being used or adapted for the prevention of ODs.

These type of devices include closed-loop implants that directly inject naloxone into the body after sensing, wristbands/smartwatches, ring sensors, clothing tags, necklaces, skin patches, supervised calls and room-based sensors. The signs of OD detected by sensors include respiratory rate (the most common), motion, response to prompts, oxygen saturation, heart rate, temperature, and press button. The report described in more detail ten devices that are used for OD prevention or could be adapted for this purpose.

The report also analysed first responder applications by categorising them into three groups: a) “information applications” which provide information related to overdose, naloxone and how to use it when it is needed and information about response to overdose situations. It identified ten applications in this field. b) “responder applications” which monitor individuals using drugs to avoid overdose. It identified ten applications in this area. c) “connect carriers of naloxone” which connect people who are carriers of naloxone to individuals who need it. It identified two applications in this area that had potential in Scotland.

Analysing the features of these applications, their readiness for implementation, and costing plans show that none of the existing applications can meet all the needs and priorities of Scotland.

Therefore, this report proposed a three-staged plan for ongoing work:

Stage 1 The short term plan was to meet the immediate emergency need and proposed implementing one of three identified applications from the analysed list in Scotland.

Stage 2 The intermediate plan, as part of the Scottish Government Digital Health and Care Strategy, was to initiate a drug death specific programme that would utilise expertise and technologies

already available within the industry, public and academic environments to work together through the support of the Scottish Health Innovation Partnership (SHIP) and establish an ecological valid overdose detection device that is fit for purpose.

Stage 3 The intermediate and long-term plan was to develop a modular integrated application which could provide services to different organisations to support the prevention of fatal overdose.

4. Consultation with Stakeholders

The ODART team conducted seven focus groups to obtain information from stakeholders on the acceptability, strengths, and limitations of digital technologies to prevent drug overdose. Six of these focus groups discussed the technologies that are being described, namely sensor-based devices to detect overdose and prompt alerts, and smartphone applications to reduce risks of overdose death. Two of the focus groups consisted of PWUD, two consisted of people providing services for PWUD, mainly drug treatment services, and two consisted of family members of PWUD. The seventh focus group focused on the use of online consultations for PWUD.

A full analysis of the data has been undertaken as part of a Master's thesis (Dumbrell, 2022) see section 5.2.1. Key points to highlight are:

- These technologies were well-received in general. Most participants, both those with lived experience and service providers, were enthusiastic about their potential, and some individuals with experience of substance use say that they would have been very useful for them when actively using drugs.
- Room-based devices were considered easy to implement but not sufficient. Some of these technologies are already being used, but our participants agreed that much of the high risk drug use took place outdoors or outside someone's home. This is especially true for the more vulnerable people. Other technologies that monitor the individual as they are out and about, even if harder to implement, would provide an extra layer of safety.
- Use of smartphones is not generalized so limits capacity. Even though it is not uncommon for many PWUD to use smartphones, there is a significant group who do not use them consistently. It is not rare for people in this group to lose their phone, or on some occasions to sell it. In addition, some people, especially the most vulnerable and the older ones, are not digitally literate and would need to learn how to use some of the functionalities. Digital inclusion and training along with any intervention is necessary.
- Discreetness and stealth are very important for these technologies to be used. If the devices that are worn are seen by others and perceived to be of high value, this puts their users at risk of being robbed or intimidated. Additionally, some people could be tempted to sell them in times of need. Therefore, wearable devices should not be too visible and should not look like something expensive.
- False positives could undermine acceptability. If those using these technologies are constantly bothered by alarms or woken up unnecessarily, there is a risk of them stopping using them.

Using naloxone on someone can get that person into withdrawal symptoms and this can be an unpleasant experience. If this is done unnecessarily it could create some aversion for these technologies. Therefore, it is important that sensors are well calibrated, and algorithms adjusted, if possible to the individual level. There is a challenge in having enough sensitivity to detect OD and prevent death, and enough specificity to allow users to live within their normality.

- Data privacy. For some PWUD, disclosing their location and activity can be perceived as risky. Privacy of their data at all times must be assured and the vulnerability of this particular group should be accounted for throughout the whole system.

Specific feedback on smartphone apps:

- **Information apps:** They were regarded as very useful apps for informal carers of PWUD such as family members, friends, neighbours, and peer support to increase their knowledge and information of the issues involved around PWUD and information on how the carers can provide support and help for individuals in overdose situation. These apps can be more useful when being more interactive and providing videos and pictures of step-by-step rescue plans for overdose rescue situations including use of naloxone. These apps are not perceived as being useful in panic situations or emergencies to instruct how to use naloxone. But they are very helpful for understanding the situation before it occurs. Service providers believe these kinds of apps are very handy for training and supporting PWUD. They believe these apps can help to increase the culture of use of naloxone by promoting and improving the confidence of its use.
- **Responder apps:** PWUD and service providers provided positive feedback on these types of apps. One of the challenges underlined by PWUD was to introduce someone else such as a friend, or family member to the app to monitor them when they were planning to use drugs. In some cases, it can be complicated for vulnerable people to introduce a friend, family member or someone else, and they prefer to talk with a peer support which could be introduced by the apps. Another point highlighted by participants with experience of drug use was that their information and their situation should not be made available to the police. They were very cautious about sharing data specially their geographical location. Also, the security of their data was emphasised as being very important for them.
- **Connecting carriers of naloxone:** There was optimism about the use of this type of app across groups. Participants were very keen to use these and several were willing to register as a volunteer to help other people in need of naloxone. But misuse of apps such as sharing their data with other users or police and finding each other through an app, was deemed as one of the challenging issues that were highlighted by end users. Service providers believed this type of app can save those individuals who are hesitant to carry naloxone as it will connect them to naloxone holders in situations of overdose.

The consultation work described above will be prepared for a peer reviewed publication as it is a unique addition to the evidence base.

5. Project Impact

The ODART project has had considerable impact on policy, practice and developing the evidence in this emerging field. These are described below.

5.1. Ongoing and Emerging Initiatives

Two of the work packages of the ODART project have secured funds for follow-up projects. Work package 2 which was in "Overdose First Responder" and work package 4 "Remote addiction consultations" have secured funds from TEC under the umbrella of the Digital Lifelines Scotland programme. These are described below.

5.1.1. Here4U Scotland (ODART-RAP) (work package 2) (University of Stirling)

A comprehensive international market analysis was undertaken, and this identified that the Brave App was the only product currently available that looked able to meet the needs of the proposed service implementation within the planned timescale. The Brave app was also more cost-effective, compared to other applications with similar functionality.

This project received funding through the Digital Health and Care Directorate of Scottish government. The project aims to evaluate a partnership project between Brave Technology Coop, Digital Health and Care Innovation Centre (DHI), and Alcohol & Drug Action in Aberdeen to pilot the Brave app in Aberdeen City for people at risk of overdose.

Specific objectives are to:

1. Understand the willingness of PWUD to take up the opportunity to use the application;
2. Assess the acceptability and usability of the application by PWUD;
3. Assess the acceptability and usability of the application by supporters;
4. Explore the views and experience of other community stakeholders (service providers for harm reduction and homeless services, local policy makers, Scottish Ambulance Service (SAS), and Police) on supporting such an application in their local community.

The Brave app links people who are using drugs in homes or hostels to a community of 'supporters'. When someone is about to use a drug e.g., injecting heroin, they use the app to link with a 'supporter'. The supporter can be a friend or community member and will keep in contact with that person until the 'at risk' period is over. If the person fails to respond, then the supporter can activate the community response.

Through the co-design workshops the Brave app is being adapted to the Scottish context and renamed as "Here 4 U Scotland". Here4U Scotland is a remote mobile application which is uniquely placed to help those who use drugs alone to provide them with support from private, anonymous non-judgmental people who are experienced in preventing DRD. It connects people who are consuming drugs alone to volunteer supporters who remain present and on the line with them during the period when there is potential for overdose.

This app works by allowing community members to call when using drugs to speak to a peer support volunteer, but their privacy remains secured due to the anonymity criteria within the app.

Volunteers will ensure members are responsive and safe throughout the call while also engaging in conversation and providing a supportive ear, harm reduction advice and ensuring that the community member receives the appropriate care. The rescue plan allocated by users, where they detail their location plus how, when and who should be contacted, will only be accessed if the member experiences difficulty or is unresponsive to the initial emergency act.

This app also includes enhanced psychological well-being as members feel valued and part of a community that is not further marginalised. It is intended to provide multiple benefits for communities, individuals, and health services to mitigate against unsafe, unclean, dangerous, or toxic uses of drugs.

Currently, ADA in Aberdeen City is recruiting Volunteer Supporters who would be able to support users, before, during and after the person calling, providing advice on safer practices and reducing harm. In the event of an overdose occurring, volunteers will need to fulfil the agreed rescue plan by calling emergency services or reaching out to someone the app's user has identified as being close by who can help.

5.1.2. ONLINE ENGAGEMENT (OLE) - Increasing Engagement of Opioid Users in Treatment through Online Consultations (St Andrews University)

For PWUD, engagement in treatment not only increases the chances of recovery but also decreases the chances of drug-related death and all-cause mortality. Evidence shows that medication assisted treatment (MAT) can reduce DRD by 50% (Santo et al., 2021). There is strong evidence that digital health and care can facilitate engagement in treatment, improve outcomes, knowledge and self-care management among populations subject to health inequity in developed countries, provided there is meticulous co-design and tailoring of the intervention to counteract unequal access and delivery (Armaou et al., 2020).

The COVID-19 pandemic has forced services to engage with their patients without physically visiting facilities. However, NHS Scotland´s Near Me platform for online health consultations has not been widely recognised, accepted, and used as a tool by both patients and treatment providers, to keep PWUD in contact with treatment services during the pandemic. Exploring barriers and facilitators to implementation of a digital approach will help understand what changes are needed to promote the use of Near Me, which is already embedded in the Scottish health care system and can be an ideal tool to provide online services for PWUD. We believe that it can, not only be used for its standard functionality of making videocalls, but also offer a broader range of sociosanitary and harm reduction services to PWUD.

Outcome measures for services are aimed at assessing whether what is being provided is effective in achieving health gains, like whether improving or reducing doses might result in an improvement of a patient's health and wellbeing.

The general aim of the project is to increase treatment coverage and engagement with the treatment of PWUD in Scotland, especially for those at high risk of overdose. We will do this by:

1. Finding evidence for the core elements of digital interventions that enhance the therapeutic relationship. In other words, finding out what works to enhance the therapeutic relationship through digital platforms.
2. Proposing and adapting a tool to measure the improvements that the introduction of those core elements of digital interventions bring to the therapeutic relationship once implemented.
3. Proposing improvements to the Near Me platform as well as a package of features/addons that could be added to Near Me to improve the therapeutic relationship and, consequently, engage more PWUD in treatment.

In order to measure outcomes of a future OLE implementation, we will use the Visual-Alcohol & Drugs Outcome measure (Visual ADOM-R) (Galea et al., 2015), developed in New Zealand by one of the members of this project, which is designed to facilitate patients' recovery and person-centred planning through the use of a pictorial representation of changes in health status. This tool is also specifically designed for use in addiction services.

In conjunction with the OLE project, DigitAS phase 3 of the TMAT programme will co-design an implementation framework to inform the delivery of digital health within addiction services and evaluate implementation applying a human centred design process and learn from the experiences to inform a wider launch of TMAT (telehealth mediated medication assisted treatment) across Scotland. Phase 3 (initiated in 2022) is an important continuation of the 'Good Practice Guidance' for TMAT and will inform Health Boards in Scotland on strategy development and execution to achieve the practice change needed to deliver TMAT. As part of the DigitAS programme at St Andrews University, the OLE project will build on the Phase 3 work to achieve the aim of enhancing engagement of PWUD. It benefits from the synergies already established with NHS Scotland and addiction services and the early implementation of TMAT, which will serve as a test bed for the assessment and development of Near Me functionality for both patients and treatment providers.

5.1.3. MRC Project Submission

Related to work package one, a collaboration led by University of Bristol with partners at the University of Stirling, Queens University Belfast and Manchester Metropolitan University has submitted a substantial grant application for a wearable device for the early detection of overdose. This unique proposal combines laboratory measurements and real life testing of a wrist wearable to define and validate the combination of physiological measures to detect an imminent overdose. The proposal has been submitted to the Medical Research Council. Consultation and scoping work in the ODART project informed the bid. Catriona Matheson and Josh Dumbrell are co-applicants and Alex Baldacchino an expert adviser.

5.1.4. Naloxone box project

An application was submitted to the Corra Foundation for a multi-centre trial of publicly accessible naloxone e.g. using Naloxobox, (or another hardware provider). Unfortunately, this was not funded but Aberdeen City is progressing with this through ADP funds. Sites in indoor public places have been identified near to 'hotspots' for ambulance call outs. Indoor sites will be the initial focus until more robust hardware is confirmed for outdoor use. This is still in the late planning/pre-

implementation stage, but learning is being shared with the original interested group who were part of the unsuccessful Corra application.

5.1.5. SHIP (Scottish Health and Industry Partnership)

The Scottish Health and Industry Partnership Group (SHIP) is an initiative hosted by the Chief Scientist Office (CSO) of the Chief Medical Officer Directorate and the Enterprise and Innovation Division of the Economic Development Directorate. It is aimed towards strengthening Scotland's innovation activities in health and social care in order to solve real problems and improve quality, efficiency and sustainability of healthcare. SHIP will support Scotland's economy through activities that strengthen its life sciences sector, attract investment into Scotland, develop large scale innovation projects and support the growth of robust businesses.

ODART has been instrumental in supporting the initial stages of the Scottish Health and Industry Partnership (SHIP) Drug Death Consortium one of five consortia set up by the Scottish Government in March 2022. The results and recommendations from the ODART report allowed SHIP consortium chaired by Professor Alex Baldacchino and, participating in the consortium Professor Catriona Matheson, the scope for the first challenge call due out in December 2022.

This open innovation challenge call specifically provides an opportunity for companies, working individually, collectively and/or in partnership with regional Scottish innovation test beds to develop disruptive innovative solutions that focus on Identifying and responding to early acute risk of non-fatal and fatal overdose using mobile technology such as.

- Wearable devices
- GPS receivers
- Smartphone apps
- Virtual reality
- Gamification
- Data analytics

5.1.6. Peace Plus

Members of the ODART project team (AB and AO) are working with teams in Ireland to work towards a PEACE Plus application which could see the replication and development of ODART across the island of Ireland.

5.2. Reports and Publications

5.2.1. Academic Publications

Overdose alert and response technologies (ODART): a state-of-the-art review (peer-reviewed journal article)

As part of the study, we conducted systematic review of the different technologies to avoid overdose death. This part of the study has been submitted for peer review to a Journal of Medical Internet Research and is under review for publication. The aim was to identify overdose-specific digital technologies being developed, implemented, and evaluated. We classified the various

technologies based on their characteristics and functionality as well as describing and classifying studies thematically.

A systematic search was conducted on Medline, Embase, Web of Science, Scopus, ACM, IEEE and SciELO. We also searched references from articles and scanned the grey literature, including industry websites and forums. The search included terms relating to telehealth and digital technologies, drugs and overdose, and included papers published since 2010. We classified our findings by type of technology and its function, year of publication, country of study, study design, and theme. We performed thematic analysis to classify papers according to main subject.

Included in the selection were 17 original research papers, two proof-of-concept, four reviews, three US government grant registries and six commercial devices that had not been named in peer-reviewed literature. All were published between 2017 and 2022, with a marked increase since 2019. All were based in or referred to US or Canada and concerned opioid overdose. Nine papers either evaluated or described devices designed to monitor vital signs and prompt an alert once a certain threshold indicating a potential overdose has been reached. Ten papers focussed on technologies to alert potential responders to an overdose and facilitate response. Eleven papers and four commercial devices described combined alert and response devices. Sensors monitor a range of vital signs, like SPO2 level, breathing rate or movement. Response devices are mostly smartphone apps to enable responders to arrive earlier at an overdose site. Closed-loop devices that are able to detect an OD through a sensor and automatically administer naloxone without any external intervention are still in an experimental or proof-of-concept phase. Studies were grouped into four themes: acceptability, efficacy/effectiveness, device usage and decision-making, and description of devices. Studies showed a high level of acceptability among potential users.

There has been increasing interest in research and application of these technologies in recent years. Literature suggests willingness to use these devices by people who use drugs and affected communities. We have concluded that more real-life studies are needed to test the effectiveness of these technologies to adapt them to different settings and populations that might benefit from them.

Towards a Theory of Overdose Prevention Technology Acceptability for People Who Use Drugs, Affected Family, and Service Providers (MSc dissertation)

As part of the study, an MSc Student (Mr Joshua Dumbrell), also worked on this project as a peer-supporter to conduct focus groups, analyse the conducted consultation data under the supervision of Professor Matheson and Dr Daneshvar. His thesis is submitted as an MSc dissertation to the University of Stirling.

The aim of this part of the study was to understand the factors involved in the acceptability of technology for reducing overdose and drug-related deaths – towards a theory of harm reduction technology acceptance for PWUD, affected family, supporters and service providers. The research questions are:

1- How can digital technology be used to reduce drug use harms and death, from the perspective of individuals, families and service providers?

2- What factors are involved in technology acceptance for PWUD, family members and service providers?
3- To what extent does the TPOM framework support the development of a model of technology acceptability for risk reduction PWUD?

A qualitative study was conducted using a focus group methodology. The target groups were people with lived experience of problem drug use [n = 9], affected family members [n = 4], and service providers working alongside PWUD [n = 8].

All data collection was explained in section 4 (Consultation with Stakeholders). The Technology, People, Organisations, Macroenvironment (TPOM) framework (Cresswell et al., 2020) was selected for its capacity to accommodate stakeholder insights into the socio-technical aspect of digital technologies.

The summary of the results are:

- **Technological factors**

'Digital divide'

Digital literacy, personal stability, organisational resources and wider economic constraints were identified as key facets of the technical challenge for designers of fatal overdose prevention technology. Analysis revealed these phenomena to be further characterised by age, drug use status and differential service provision across geographical locales.

'Data implications and opportunities'

Associated with performance, usability, user satisfaction and engagement, content captured under this theme broadly concerned the availability and accuracy of data and its implications for behaviour.

- **Social/human factors**

'Harm reduction, privacy, safety and ambivalence'

Analysis uncovered a number of interconnected challenges faced by developers and implementation teams related to creating acceptable products that can feasibly support fatal OD prevention in Scotland. Under the meta theme 'challenges to acceptability', participant data describe how digital harm reduction interventions must strike a delicate balance between safety, privacy, and individual autonomy amidst high-levels of health ambivalence among PWUD.

'Trust – in technologies, systems and people'

Spanning three dimensions of the TPOM, trust was a major theme relating to the acceptability of technological solutions for reducing overdose, though this was approached in different ways across participant groups. From a technological perspective, trust was closely linked to data security, privacy and confidentiality

'Readiness – a double bind'

The sociotechnical task of engaging high needs PWUD in digital interventions was discussed across participant groups and findings suggested willingness to participate constitutes a 'readiness double

bind'. That is, those at highest risk, and most in need of interventions, are the least able to engage with them, while individuals more likely to be receptive may not be interventions' target population

- **Macroenvironment**

'Co-produced community OD response'

While most participants expressed enthusiasm about proposed technologies and their capacity to reduce harms and death, they were cognisant of the macroenvironmental influence of buy-in across and beyond groups affected by drug use

The theme of digital divide accords closely with findings elsewhere. These shared conclusions illustrate that attention to digital exclusion, through support from organisations and prioritised funding streams, are a prerequisite for the acceptability and feasibility of an effective digital harm reduction strategy.

Though evidently well documented, solutions to this 'double bind' situation for high needs PWUD, who stand to benefit most from interventions yet are unable to access them, are lacking, Present investigations identified a complex balance of harm reduction, privacy, and safety that must be achieved for digital OD interventions to be acceptable to PWUD. This idea is underdeveloped within the ODART literature, and further exploration is warranted.

Effective digital OD prevention strategies will need to be sensitive to the complex relationships between technological, social/human, organisational, and wider macroenvironmental factors which can enable or impede intervention delivery. Concerns of readiness, accessibility, trust, rights, stigma, and meaningful collaboration are factors central to technology acceptability

5.2.2. Drug Deaths Taskforce Report

The Scottish Government has launched a coordinated suite of measures to tackle the drug-deaths crisis in Scotland. As part of this, the Scottish DDTF was established in July 2019 to identify measures to improve health by preventing and reducing drug use, harm, and related deaths. One of the aims of the ODART project was to report to DDTF. The ODART team presented to DDTF on two occasions to provide a summary of the work.

In June 2022, DDTF published a final report with the title "Changing Lives". This report reviews the current situation and provides 20 recommendations for the Scottish Government. Recommendations are influenced by the ODART recommendations. The DDTF report directly mentions the ODART report as action 119.

5.2.3. Conferences Presentations

The results of ODART have been/will be presented in at several events. Researchers will present findings from ODART in:

- International Society of Addiction Medicine (ISAM) Global Congress (Virtual) 19th -21st November 2021
- International Society of Addiction Medicine (ISAM) Valletta World Congress 4th -7th October 2022

- Society for the Study of Addiction (SSA) conference on the 3rd-4th November 2022
- Lisbon Addictions Congress on the 23rd-25th November 2022.
- The Drug Research Network Scotland (DRNS) will also host a Technology to Reduce Drug Harms meeting/webinar in early 2023.

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