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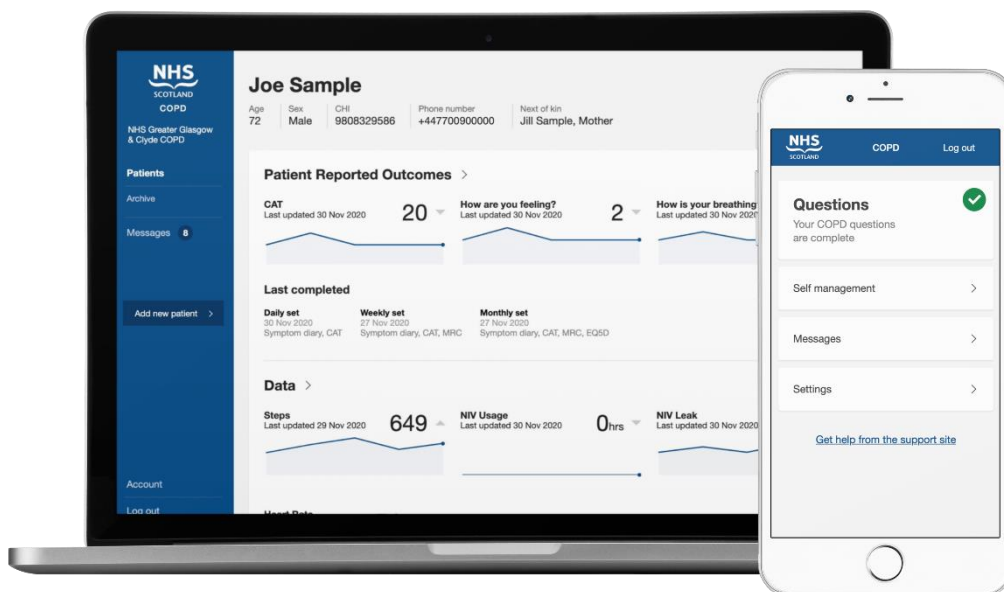
Innovative Medical Technology Overview

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NHSScotland COPD Support Service: remote and self-management of high-risk patients with COPD using a web app and machine learning predictive modelling.

Executive summary

The Scottish Health Technologies Group (SHTG) was asked by the Dynamic Scot Board to assess a local trial and evaluation of the NHSScotland COPD Support Service, which comprises a web app to support remote and self-management of high-risk patients with Chronic Obstructive Pulmonary Disorder (COPD).[1] The local trial and evaluation was carried out by NHS Greater Glasgow and Clyde (NHS GG&C).

COPD is a collection of lung diseases including chronic bronchitis, emphysema and chronic obstructive airways disease.[2] People with COPD have difficulties breathing. The web app is intended to promote remote and self-management through regular recording of self-reported health measures and asynchronous communication between patients and clinicians.

The innovative aspect of the NHSScotland COPD Support Service is the machine learning predictive modelling (under development) to predict risk of exacerbations, readmission and mortality. The predictive models also stratify patients into high and low priority categories to alert clinicians of a change in a patient's disease status.

The local trial was paused after recruiting 83 participants, as the NHSScotland COPD Support Service was scaled up to cover the whole of NHS GG&C during the COVID-19 pandemic. Initial findings show a high level of engagement with the web app. When the projected trial results were compared with an historical cohort, the COPD service appeared to have no impact on 12-month mortality rates but there was a decrease in occupied bed days, 3-month admission rates, and numbers of community respiratory reviews.

Initial predictive modelling found that patients deemed high priority by the model have a 71% 3-month readmission risk and 58% 12-month mortality risk.

There is uncertainty if recruitment and engagement rates across the whole of NHSScotland will mirror that of the local trial. It is also unknown if those who engage with the NHSScotland COPD Support Service will be the patients who will be deemed high or low priority by the machine learning predictive modelling as this will affect potential clinical impact.

Technology and innovative aspect

The NHSScotland COPD Support Service[1] is funded by the Digital Health & Care Innovation Centre and Innovate UK. The NHSScotland COPD Support Service comprises a web app which is in use and machine learning predictive modelling which is still in development.

Web app

The web app, accessed via a smart device, is intended to promote self-management and remote management of high-risk patients with COPD. Within the web app, patients complete the following self-reported outcome measures: COPD Assessment Test (daily), symptom diary (daily), Medical Research Council Dyspnoea Scale (weekly), healthcare episode questionnaire (weekly), EQ-5D-5L (every 4 weeks). Their clinician has access to these results in an online clinician dashboard. The clinician and patient have the option to communicate via asynchronous messaging. Monitoring of patients' conditions is on a case-by-case basis with the onus on the patient to contact the clinician if their condition has changed.

The web app and clinician dashboard are hosted on a cloud based system. The developers report that the cloud is General Data Protection Regulation 2016/679 compliant and has been subject to security and penetration testing evaluations.

Machine learning predictive modelling (still in development and has not been tested in practice)

Separately to the web app, machine learning predictive modelling is being developed as part of the NHSScotland COPD Support Service. The purpose of the modelling is to give real time predictions of how likely a patient is to have an exacerbation in the next 72 hours, their risk of readmission to hospital in the next 3 months and their 12-month mortality risk. As well as giving a measure of risk, the machine learning predictive modelling categorises the user of the web app as either high or low priority for these three outcomes, alerting a clinician to a negative change in condition and allowing them to act proactively.

Target patient group

The NHSScotland COPD Support Service is intended for high-risk COPD patients, defined as those who have recently presented to secondary care with an exacerbation of their COPD or who have persisting hypercapnic respiratory failure. Patients must have access to, and ability to use, either a smart device or a web browser with internet access.

Current practice and use of technology in pathway of care

COPD exacerbations are commonly managed in a reactive fashion when a patient presents to primary or secondary care. This web app and machine learning predictive modelling are intended to allow patients and clinicians to respond proactively to a change in condition.

The desired outcome from use of the web app is that people with COPD will experience fewer exacerbations and improved outcomes, alongside a subsequent reduction in associated resource use across both primary and secondary care.

Product performance: unpublished local evaluation

The web app was piloted in an observational cohort trial in the north and south sectors of NHS GG&C (C Carlin, Respiratory Consultant, NHS GG&C. 28 Jul 2020). The primary outcome measure of the trial was the extent of patient engagement with the web app, quantified by the number of times per week a patient submitted a self-reported outcome measure. The recruitment target of the trial was 400 participants (100 in a home non-invasive ventilation group and 300 in a COPD exacerbation group). Between September 2019 and March 2020, 83 participants were recruited (an approximate 50% successful recruitment rate, which was the projected rate). At this point recruitment was paused, the trial halted, and the project was scaled to cover all secondary care COPD patients in NHS GG&C as part of the COVID-19 response. The developers estimate that 1,500 patients will be invited to participate in the scaled-up project.

Results from the observational cohort trial (web app)

Descriptive statistics from the observational cohort trial include (as of June 2020):
- Mean number of self-report outcome measures of 4.6 (out of a possible seven) per patient per week
- No study related adverse events
- Nine patients died.

Data (based on a minimum of 3 months follow-up) from the 83 participants were projected across a 12-month period and compared with an historic and contemporary control group (electronic health records from 2010–June 2020 minus those enrolled in trial).

Caution should be used when interpreting the following results due to the projection of the observational cohort results to an annual basis and a lack of statistical power. There may also be inclusion bias as the patients that choose to enrol may not be representative of the target population. Lastly, there was no information provided if there were any technical issues encountered with the web-app.

Comparisons of the observational trial cohort with the historical and contemporary cohort report the following in relation to use of the web app:
- no impact on 12-month mortality rate
- 28% reduction in annual admissions
- 38% reduction in annual occupied bed days
- 57% reduction in annual community respiratory reviews.

Interim machine learning predictive modelling results

The machine learning predictive modelling is based on the same historical and contemporary cohort, from electronic health records, supplemented with the limited data from the observational cohort. The models are still in development, but early results presented by the developers state that, based on the current data, a patient in the high priority category has a 71% 3-month readmission risk and a 58% 12-month mortality risk. These machine learning predictive models are yet to be validated in a real world cohort.

Safety

The developers reported that there were no adverse events related to the observational cohort trial.

Nine participants died during the trial. The developers and professional commentators reported that this was typical of this patient population.

The developers and professional commentators also note that people should not be impacted adversely by using the web app because the alternative is standard care, which is to present at primary care with an exacerbation.

Economic and cost considerations

The developers projected an annual 38% reduction in occupied bed days. This would carry economic benefits of saved resources.

Costs of maintaining the web app are unclear at this time. It is also unclear how much clinician time and at what grade is required to run a service with this web app. It is also unclear if using the machine learning predictive modelling will have an economic impact.

User experience and other considerations

Nine participants who had used the web app took part in individual structured interviews with the developers. Participants answered questions on patient experience of being in the trial and the usability of the web app. All comments and quotes reported were positive. It is not known how representative the nine participants are of the target COPD population or how generalisable their experiences are.

The web app may provide the opportunity to empower some people with COPD to take more control over their condition and self-manage their condition at home and potentially reduce pressure on both primary and secondary care.

Participants need access to the web app and capacity to use it. This has the risk of generating an inequality in access by implementing a digital care pathway in a group who may not be familiar with or have access to a smart device to access the web app.

It is not known if the 50% who are expected to enrol to use the web app will be in the category of high or low priority from the machine learning predictive modelling. If the majority of the people who use the web app are categorised as low priority by the machine learning predictive algorithm then this will reduce the usefulness of the predictive modelling as most of the high priority patients will remain unreachable, will still behave reactively to their condition and remain a burden to secondary care.

Considerations for scale, spread and future analysis

The NHSScotland COPD Support Service is currently being scaled across the whole of NHS GG&C. There are a number of uncertainties surrounding the use of this technology, which relate to the scale and spread of this project.

Requirement for further evaluation of effectiveness

The observational cohort trial ran for only 10 of the planned 24 months, and recruited only 83 participants instead of the intended 400 participants. Caution should be used when interpreting results derived from extrapolating short-term data over a longer period. It is unclear if the level of enrolment across NHS GG&C will be the same as experienced during the trial (50% level of uptake) or if the level of engagement (4.6/7 self-report outcome measures submitted per week) demonstrated by the 83 participants will be replicated in the approximate 750 patients who are predicted to sign up. The robustness and applicability of the machine learning predictive modelling is yet to be tested in a real world setting.

Not all health boards in Scotland have the same patient pathway for COPD patients and, based on the results of this trial, it is not possible to predict the impact of spreading the NHSScotland COPD Support Service project to other boards. For example, not all health boards in Scotland will have a community respiratory team for COPD.

Recommendations for future analysis

Future work should include:
- a validation of the machine learning predictive modelling in a real world cohort.
- continued analysis of the scaled project in NHS GG&C to see if the indicative results of the cohort trial are validated. Clinical outcome measures should be more clearly defined and collected at 3, 6 and 12 months.
- an economic analysis of the impact of the new pathway when appropriate data are available.
- continued measurement of user experience using qualitative methods should be conducted after scale is implemented, and measured at 3, 6, and 12 months.
- an assessment of impact on inequalities of those using and not using the NHSScotland COPD Support Service.

The outcomes of these analyses should inform the further refinement and development of the pathway.

Conclusions

Indicative results from the observational cohort trial are encouraging in that, by extrapolation, hospital admissions and community assessments are expected to reduce in the 83 participants. The machine learning predictive modelling, if validated, could provide clinicians with a tool to act proactively in the care of those high-risk COPD patients who are willing to use the web app.

The NHSScotland COPD Support Service is being scaled throughout NHS GG&C. If the anticipated effects seen in the initial part of the observational cohort trial are realised, roll-out of the web app could lead to a reduction in COPD-related events, reductions in readmissions and a shift in services to home or community setting for a subgroup of stable patients.

Continued assessment of the NHSScotland COPD Support Service as it is being scaled is required to confirm any beneficial effects and inform further development of the pathway.

References

1.   NHSScotland COPD Support Service. NHSScotland COPD Support Service [online]. 2020 [cited 2021 Jan 21]; Available from: https://support.nhscopd.scot/

2.   NHS Inform. Chronic obstructive pulmonary disease [online]. 2019 [cited 2021 Jan 21]. Available from: https://www.nhsinform.scot/illnesses-and-conditions/lungs-and-airways/copd/chronic-obstructive-pulmonary-disease

Acknowledgment of professional commentators and fact checking

Professional commentary was provided by:

- a respiratory consultant, NHSScotland, and
- a specialist respiratory physiotherapist, NHSScotland.

Declarations on interests were obtained from professional commentators.

What is an IMTO?

An IMTO provides a high-level summary of the evidence surrounding health and care innovation in Scotland. IMTOs may include:

- a review of local evaluation(s) undertaken within NHSScotland
- an appraisal of the evidence, based on the health technology assessment framework
- bespoke analysis and advice towards the development of evidence.

The purpose of an IMTO is to raise awareness of promising innovations and to assist local decision making by health and care colleagues. Further information about the IMTO process can be found on the Healthcare Improvement Scotland webpage.