



# Kinesis QTUG™ Economic Analysis

## KINESIS QTUG™ HEALTHCARE ECONOMIC EVIDENCE AND ANALYSIS

VERSION 2.2

Sources:

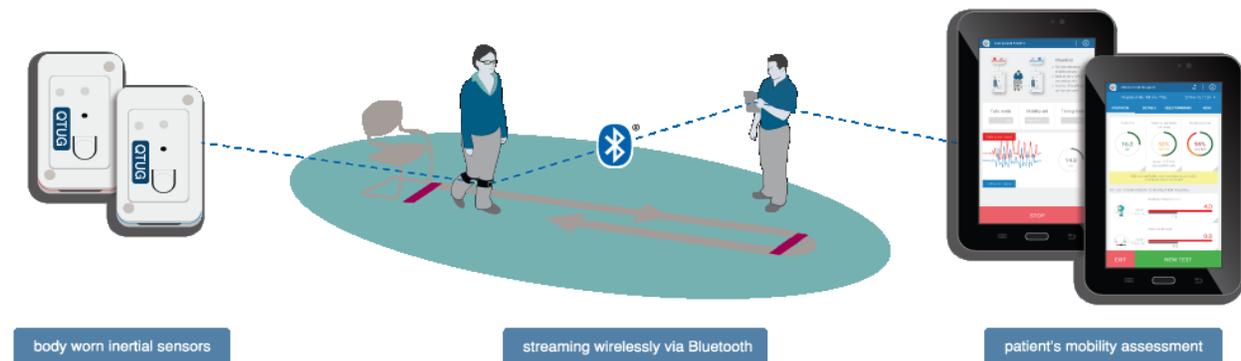
1. "The benefits of QTUG™ over traditional tug in falls prevention", Kinesis Health Technologies, 2020
2. Franklin M, Hunter RM. "A modelling-based economic evaluation of primary-care-based fall-risk screening followed by fall-prevention intervention: a cohort-based Markov model stratified by older age groups". *Age and Ageing*. Vol 49, Issue 1, 2020, pp57–66.
3. "Sheffield city region NHS testbed, 'Perfect Patient Pathway' - final evaluation report", University of Sheffield, School of health and related research, Sheffield, UK, 2018
4. "Evaluation of the NHS England innovation test bed at care city", UCL Partners, London, UK, 2018.
5. "Support Services for the Management and Utilization of Monitoring and Assessment of the EIP - MAFEIP Tool - Kinesis QTUG™" EU funded economic evaluation of QTUG

## The Benefits of QTUG™ over Traditional TUG in Falls Prevention:

### A Patient Outcome and Economic Model

Falls are well recognized as a major and increasing problem as populations age. Worldwide, one in three people over the age of 65 fall each year and approximately 20% of those falls result in injury requiring hospitalization, costing the U.S. healthcare system over \$50 billion annually<sup>12</sup>. Many of these falls are preventable and studies have shown that 30-50% of falls can be prevented through early intervention<sup>3</sup>.

Early identification of people who are appropriate candidates for intervention is therefore crucial to prevent falls. The Timed Up and Go (TUG) test is a widely used and useful test for the rapid assessment of falls risk in older adult populations. The protocol is simple; A patient starts out seated, gets up, walks 3 meters, turns around, walks back and sits down. The process is timed, and if the patient's time is over a cutoff time, the patient is referred for intervention. Kinesis has improved upon this basic protocol by adding wearable sensors to quantify all the different aspects of the test. The software automatically calculates the patient's risk of falling, helps identify the source of that risk<sup>4</sup> and provides tailored advice of preventing falls.



Kinesis QTUG™ (Quantitative Timed Up and Go) product (shown above) maintains the convenience and ease of use of the TUG test but with significantly more accurate results. The table below compares the accuracies of the assessments of QTUG™ and two standard cut-off time for the TUG test which span the typical range used. This analysis is for a sample population of 1000 patients with an expected prevalence of falls of 33.3%.<sup>5</sup>

<sup>1</sup>See WHO Department of Ageing and Life Course. "WHO global report on falls prevention in older age". 2007.

<sup>2</sup> Burns EB, Stevens JA, Lee RL. "The direct costs of fatal and non-fatal falls among older adults-United States". J Safety Res 2016:58.

<sup>3</sup> See, El-Khoury, F., et al., "The effect of fall prevention exercise programmes on fall induced injuries in community dwelling older adults: systematic review and meta-analysis of randomised controlled trials". BMJ:British Medical Journal, 2013. 347.

<sup>4</sup> Greene, B.R., McManus, K., Redmond, S.J. et al. Digital assessment of falls risk, frailty, and mobility impairment using wearable sensors. npj Digit. Med. 2, 125 (2019) doi:10.1038/s41746-019-0204-z

Barry R. Greene, Stephen J. Redmond, Brian Caulfield, "Fall risk assessment through automatic combination of clinical fall risk factors and body-worn sensor data" IEEE J. Biomed. Health Inform. 2016, 21(3).

<sup>5</sup> The population size is the estimated capacity of a single QTUG system, based on 10 tests per day, 250 days per year, administered every six months, with additional tests given to a portion of the population.

**Table 1: Patient Outcomes Comparison**

	QTUG™	TUG w/ 12 second cutoff	TUG w/ 15 second cutoff
Total number of patients identified at risk	284	238	101
Number of fallers correctly identified	221	134	63
Number of fallers that were missed	109	196	267
Number of Falls Prevented <sup>6</sup>	88	54	25

As can easily be seen from this table, QTUG™ provides a far more accurate assessment – correctly identifying over two-thirds of the fallers. In contrast, TUG with a 12-second cut-off only catches 41% of fallers and with a 15-second cut-off *fails* to identify 81% of the fallers. Most importantly, QTUG™ prevents over 60% more falls compared to the TUG with 12 second cut-off and over 250% more falls compared to the TUG with 15-second cut-off.

Although the patient outcomes benefits are very compelling, most healthcare systems are under significant cost pressure. QTUG™ demonstrates very compelling benefits in this realm as well. To quantify the return on investment, we have built a very simple economic model. We assume that a typical intervention costs \$500<sup>7</sup> and the average fall costs \$9,643<sup>89</sup>. Combining these assumptions with the patient outcome data from above, this model projects that a \$10,000 investment in 1,000 assessments QTUG™ provides approximately 70-fold return in economic benefits.

**Table 2: Simple Economic Model Comparison**

	QTUG™	TUG w/ 12 second cutoff	TUG w/ 15 second cutoff
Savings from avoided falls	\$848,584.00	\$520,722.00	\$241,075.00
Costs of interventions	\$142,000.00	\$119,000.00	\$50,500.00
Cost of 1,000 QTUG™ Assessments	\$10,000.00		
Net benefit	\$696,584.00	\$401,722.00	\$190,575.00
Economic benefit of using QTUG™ instead		\$294,862.00	\$506,009.00

Of course, this simple model does not consider all the costs and benefits, and every healthcare system will have different payor and reimbursement structures. In particular, it omits many of the benefits of QTUG™ that have been experienced anecdotally. For example:

- Improvement of patient acceptance of interventions
- Increased motivation of patients to achieve improvements (e.g., achieve a certain level of QTUG™ performance)

<sup>6</sup> Assumes 40% reduction in rate of falls through intervention (e.g. Otago exercise program evidence per Cochrane review).

<sup>7</sup> Estimate based on mix of Otago group and individual exercise programs.

<sup>8</sup> Stevens JA, Corso PS, Finkelstein EA, Miller TR. The costs of fatal and non-fatal falls among older adults. Injury Prevention. 2006;12(5):290-295.

<sup>9</sup> Burns EB, Stevens JA, Lee RL. "The direct costs of fatal and non-fatal falls among older adults-United States". J Safety Res 2016:58.

- Elimination of redundant tests (e.g., 6-meter walk)
- Improved consistency of results across staff and locations
- Ability to leverage less-experienced staff to conduct the test
- Use of longitudinal data to monitor patient's response to therapy
- Ability to tailor intervention to the specific patient issues
- Provides positive feedback and encouragement to those at low risk reducing a fear of falling

Please contact Kinesis Health Technologies if you would like help developing an economic model that reflects the unique situation of your organization.

## A modelling-based economic evaluation of primary-care-based fall-risk screening followed by fall-prevention intervention: a cohort-based Markov model stratified by older age groups

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### Abstract

#### BACKGROUND:

fall-risk assessment with fall-prevention intervention referral for at-risk groups to avoid falls could be cost-effective from a care-payer perspective.

#### AIMS:

to model the cost-effectiveness of a fall-risk assessment (QTUG compared to TUG) with referral to one of four fall-prevention interventions (Otago, FaME, Tai Chi, home safety assessment and modification) compared to no care pathway, when the decision to screen is based on older age in a primary care setting for community-dwelling people.

#### METHODS:

A cohort-based, decision analytic Markov model was stratified by five age groupings (65-70, 70-75, 65-89, 70-89 and 75-89) to estimate cost per quality-adjusted life years (QALYs). Costs included fall-risk assessment, fall-prevention intervention and downstream resource use (e.g. inpatient and care home admission). Uncertainty was explored using univariate, bivariate and probabilistic sensitivity analyses.

#### RESULTS:

Screening with QTUG dominates (>QALYs; <costs) screening with TUG irrespective of subsequent fall-prevention intervention. The QTUG-based care pathways relative to no care pathway have a high probability of cost-effectiveness in those aged 75-89 (>85%), relative to those aged 70-74 (~10 < 30%) or 65-69 (<10%). In the older age group, only a 10% referral uptake is required for the QTUG with FaME or Otago modelled care pathways to remain cost-effective.

#### CONCLUSION:

The highest probability of cost-effectiveness observed was a care pathway incorporating QTUG with FaME in those aged 75-89. Although the model does not fully represent current NICE Falls guidance, decision makers should still give careful consideration to implementing the aforementioned care pathway due to the modelled high probability of cost-effectiveness.

# Sheffield City Region NHS Testbed, 'Perfect Patient Pathway' - Final Evaluation Report

## Introduction

This project used the Kinesis QTUG™ technology. The technology uses body worn sensors and a mobile software app (including a falls risk questionnaire) to assess frailty, mobility, and falls risk. It can be used by non-specialists with minimal training, and is wireless and portable. QTUG™ uses proprietary algorithms to give an objective assessment of falls risk based upon the 'Timed up and go' test. There is a NICE Medtech Innovation Briefing on QTUG™ <https://www.nice.org.uk/advice/mib73>.

The rationale underlying the intervention is that the digital technology replaces the manual Timed Up and Go (TUG) test so that with minimal training clinicians and health care assistants using the Kinesis QTUG™ device can assess and identify older people aged 65 and over at risk of a future fall. This could enable appropriate clinical decisions and referrals to falls-prevention interventions based on the information obtained. The key expected outcomes of the intervention are:

- Reduced falls risk
- Reduced injurious falls (resulting in reduced mortality & morbidity)
- Improved quality of life and wellbeing of people at risk of falling

## Falls Prevention project

In this project, the new care pathway involved identification of patients registered with one of three GP clinics in Sheffield. Patients were aged 65+, identified as 'moderately frail' on the Electronic Frailty Index (eFI) and had no clinically reported falls. Patients that are known to have fallen should be automatically referred to Integrated Community Therapy team (ICT) falls prevention services. They were invited to attend an assessment clinic at their GP practice. If they were assessed as being at high risk of having a fall, they were referred to the ICT for a fall prevention intervention. This is compared to usual care in which people are generally referred for specialist falls risk assessment and intervention after a fall has been recorded.

## Patients

Patients 180 patients were invited for assessment, and 60 attended. A total of 26 were assessed as high risk, but 7 declined referrals. Of the 20 people successfully referred to the ICT falls prevention service, 19 patients were assessed as 'high risk' of falls with the QTUG™ device, one was assessed as 'moderate risk' of falls but reported a history of falls, so was also referred onto the ICT. Follow-up assessments took place 3-months after referral and final follow-up assessments were carried out on discharge from the ICT falls prevention service.

The total number returning quantitative data are very small. However, descriptive findings are interesting. QTUG™ falls questionnaire data were available for 12 of the participants at baseline; 50% (6) reported having fallen in the last 12 months (despite not having recorded fall in their records). All were on four or more prescription medication and many had issues with mobility, their feet, dizziness blood pressure and vision. Of the ten subjects for whom we have baseline and 6-month follow-up data:

- Five showed a decrease in falls risk estimate (range -30.76 to -1.13 percentage points)
- Five showed an increase in falls risk estimate (range 0.3 to 14.7 percentage points)

## Economic model

Owing to small numbers of participants, no statistically significant conclusions can be drawn from the PROMs data. In order to assess the cost-effectiveness, in light of the lack of study-based data, an exploratory economic model was developed. According to this model, screening with QTUG™ dominates

(produces more QALYs and cost-savings) over screening with TUG irrespective of which falls prevention intervention follows. Therefore, if falls-risk screening is perceived as desirable by decision makers or clinicians, then based on this analysis, QTUG™ should be considered over TUG for this assessment in older people aged 65 to 89.

Exploratory economic modelling based results suggest that a falls prevention care pathway has a higher probability of being cost-effective (high 90% to 100%) at a specified willingness to pay (WTP; e.g. £30,000 per QALY) threshold when screening and falls prevention interventions are utilized in a population aged 75 to 89 compared to no care pathway. When screening is implemented in those aged 65 to 69, compared to doing no care pathway the probability of the pathway being cost-effective is almost zero, and it is around about 50% in those aged 70 to 74. The exact results are dependent on the specific pathway implemented in terms of type of fall-risk screening and falls-prevention intervention utilized.

For the care pathway to be cost-effective, there is a need to identify those most likely to have an injurious fall using a falls-risk assessment which has high sensitivity and specificity, in order to correctly refer people to a falls prevention intervention which has a high rate of efficacy, at a reasonable cost which is off-set against downstream care cost-savings associated with when an older person has an injurious fall.

### Community Strength and Balance Project

Between February 2018 and April 2018 a community strength and balance project, using the Kinesis QTUG™, was established, led by Healthwatch Sheffield and the STH telehealth team. The program planning group discussed various opportunities to assess recruitment in different settings and this aligned with the PPP Test Bed Advisory Group (TAG) suggesting using the QTUG in community groups. Healthwatch Sheffield contacted voluntary sector groups (such as lunch clubs) and sheltered housing schemes with members over 65 years, based on their local knowledge and experience. Once the project had started, other groups also made contact with Healthwatch Sheffield after hearing about it. The Telehealth team also made contact with community groups and sheltered housing schemes.

The QTUG™ assessment was conducted on those people who gave signed, informed, consent. The QTUG™ results (high/medium and low risk of falls) were discussed with the person. A referral for a falls prevention service with the Integrated Care Team (ICT) –Therapy was offered via Single Point of Access (SPA) if the person was either:

- Identified by the QTUG™ as at high risk of falling,
- Appeared to have needs in the clinical judgement of the community nurse although not identified as high risk by the QTUG™ score
- Reported a fall in the recent past

### Assessments and referrals

281 people had been seen by the time the project closed in April 2018. Nine of these were not fully assessed (1 under 65 years of age, 1 equipment failure, 1 unable to walk 3 meters, 6 not carried out due to concerns by nursing staff (these were immediately referred)). Of the 272 assessments conducted 138 (50.7%) were successfully referred to the ICT for the falls prevention intervention. However, the consequence of this was that a long waiting list of eight to ten weeks soon developed for the ICT falls prevention service. This indicates that a sustainable assessment service would require improved coordination with prevention and support services and possibly increased capacity or alternative support to manage referrals. This finding indicates that systems approaches are important, to consider unintended consequences and explore effects across organizations, service-providers and pathways.

## Secondary care balance clinic

Between Dec 2017- March 2018 the QTUG™ assessment device was introduced into a weekly, hospital-based balance clinic. Previously, referrals made to falls prevention were not systematic and there were no formal assessments of falls risk. Initial feedback indicates that the assessment process is suitable for a busy clinical setting, aids interactions with patients, provides systematic assessment and referral routes and is well received by patients and clinicians. A total of 45 out of 84 attendees were assessed using the QTUG™ device; seven of these with high falls risk scores (16%) were referred to the ICT falls service.

Two clinicians provided the following feedback:

- More targeted referrals than previous random ones
- Takes around 5-7 minutes to do the test; 'hence sits well in a busy clinic'.
- Tried by two users (Consultant and Clinical Fellow)
- 'Easy to put on patient' (with the new Velcro bands - not the original bandage)
- 'Easy to set up and use with the software'
- Reported by clinicians as 'well received by patients - user friendly'
- 'Data is very well presented for explaining to the patient'

# Evaluation of the NHS England Innovation Test Bed at Care City

UCL Partners, London

## The Innovation

Kinesis QTUG™, which uses accelerometers and a set of algorithms to give a quantified assessment of gait and falls risk from the standard timed up and go test, was used among over 65s by pharmacy assistants in community pharmacy and by health care assistants in primary care. As a result of these tests, the Care City team combined the use of Kinesis QTUG™ among over 65s by health care assistants in primary care with, for those identified at medium risk of falling, use of the Salaso online platform of physiotherapy exercises to reduce falls risk.

## Study Aims

We aimed to ascertain the relative cost and benefits of screening all over 65's with the Kinesis QTUG™ device, and treating those identified with a risk of falling of 50% and above with the Salaso online platform, versus no falls screening (note this differs from the 50%-70% risk band employed in the Care City testing). Secondary aims here included identifying subgroups of the population in which screening + intervention would be most cost-effective and to identify further research required to improve confidence in the cost-effectiveness results.

## Evaluation Methods

Our service evaluation comprised the development of logic models to understand how adoption of each innovation could lead to improved outcomes and/or reduced costs, use of routinely collected data to assess use of the innovations and subsequent activity and information recorded in primary and secondary care, health economic modelling and a soft systems analysis to understand differing perspectives on the proper role and function of an innovation Test Bed.

For the testing of Kinesis QTUG™ in primary care, practice level analysis was performed to see whether there was an impact on the number of falls risk assessments recorded as having been conducted and, among those, the proportion of patients recorded as having been given falls risk advice or referred to a falls prevention service.

For the testing of Kinesis QTUG™ in community pharmacy, we sought data from community based falls services (prevention and response), primary and secondary care relating to the cohort of patients tested. Health Economic analysis of the combination of Kinesis QTUG™ and Salaso was based on construction of a decision tree to incorporate the diagnostic accuracy of Kinesis QTUG™, the effectiveness of the exercise programs underpinning the Salaso tool in reducing falls and the known costs and impact on quality of life associated with falls.

## Economic Analysis

To conduct the health economic analysis of the combination of Kinesis QTUG™ and Salaso, a decision tree was built in Microsoft Excel in order to incorporate the relevant evidence of costs and benefits of a falls risk assessment tool with onward referral to an online platform where patients will be prescribed falls reduction exercises. The economic model was based on but not identical to the pathway at Care City. Only the costs incurred by the NHS and social services and benefits incurred to the patient (as measured by quality adjusted life years gained, QALYs) were accounted for in our analysis.

As is standard, the economic modelling was set in the context of the next best alternative, which in this case would be the standard of care in the UK for falls screening. In the Care City footprint, and in general

in the UK, there is no mandated national screening program for falls. Therefore, a 'do nothing' comparator was chosen, i.e. a patient either falls or does not fall in the year.

## Findings

The use of Kinesis QTUG™ by health care assistants in General Practice led to an increase in recorded falls risk assessment and, among those assessed, an increase in the provision of falls risk advice and referrals to falls prevention services, compared to comparator practices.

The testing of the combination of Kinesis QTUG™ with the Salaso online platform of physiotherapy exercises is ongoing. Health economic analysis suggests that this innovation could be cost-effective but only if compliance is consistent with the literature. It would be more cost-effective and potentially cost saving if targeted at the over 75s. It should also be noted that a proportion of patients are being provided with paper copies of the exercises due to them having insufficient internet access to make full use of the intervention.

## Conclusions

The combination of falls risk screening in general practice using Kinesis QTUG™ with a prescription to falls prevention exercises on the Salaso online platform looks promising and could be cost-saving if restricted to over 75s. However this is heavily dependent on compliance and should be reviewed once testing is complete.

Screening over 65s for risk of falling in community pharmacy and in primary care conducted by pharmacy assistants and health care assistants using Kinesis QTUG™ was shown to be feasible. However, where there is limited availability of falls prevention program, screening in isolation of other innovation or service development is unlikely to bring benefits. The combination of falls risk screening in general practice using Kinesis QTUG™ with a prescription to falls prevention exercises on the Salaso online platform is more promising.

Our health economic modelling suggests that such a program for over 65s could be a cost-effective use of NHS funds and that a program restricted to over 75s could be cost-saving to the NHS.

## Support Services for the Management and Utilization of Monitoring and Assessment of the EIP - MAFEIP Tool Kinesis QTUG™

Barry Greene, Seamus Small, Clara Faulí, Ruth Vilar, Strahil Birov, Veli Stroetmann, Francisco Lupiáñez-Villanueva

[https://www.mafeip.eu/sites/default/files/MAFEIP\\_UC10\\_KinesisFalls.pdf](https://www.mafeip.eu/sites/default/files/MAFEIP_UC10_KinesisFalls.pdf)

<https://www.mafeip.eu/the-tool>

This purpose of this case study was evaluate the utility of the MAFEIP monitoring framework that comprises a web-based tool which rests on the principles of Decision Analytic Modelling (DAM). More specifically, it is based on a traditional Markov model, an approach that is commonly used in health economic evaluations to assess the impact of healthcare innovations in terms of health outcomes and resource use. Kinesis QTUG™ was the healthcare innovation used for evaluation.

MAFEIP is based on data introduced into the tool, which may be (preliminary) data from clinical studies, expert opinions and your own views, this model performs an incremental analysis of the impact of your innovation. This means that it estimates the changes in healthcare resource use, societal resource use and health related quality of life that result from using your innovation instead of current care. As a result you would need data on both the current care situation for your target population, as well as the situation in which your intervention is used.

The results of the case study suggest that a Kinesis QTUG™ based fall prevention program will be cheaper and more effective than usual care, based on incremental cost-effectiveness ratio (ICER).

**Figure 1. Cost-effectiveness**

Incremental cost and HRQoL effects

Incremental cost (Healthcare) -7760.83

Incremental effects 0.106

Incremental cost-effectiveness ratio (Healthcare) Dominant

Cost-effectiveness plane (Healthcare)

