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Assessing the impact of a care innovation: telecare

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Abstract
The provision of health and social care for an increasing elderly population is a challenge facing many societies. Telecare, the delivery of health and social care to individuals within the home or wider community, with the support of ICT systems, has been advocated as an approach to reduce the rise of the number of elderly people in institutional care and to contain costs. A dynamic model is required to understand the systemic impact of telecare implementation over time. The presentation cautions against overoptimistic expectations of the impact of telecare in the short term and emphasises that the benefits of implementation will only become fully effective with a significant delay.

Key words: telecare, elderly care, social care, health care, implementation

Introduction

The provision of health and social care for an increasing elderly population is a challenge facing many societies. Policy makers and health professionals are seeking to develop innovative approaches to the delivery of care services. Elements of new approaches include an increased emphasis on rehabilitation, the delivery of care in new settings (such as in intermediate care facilities and the client/patients' own home) and the support for care delivery using information and communications technologies (e.g. telecare systems).

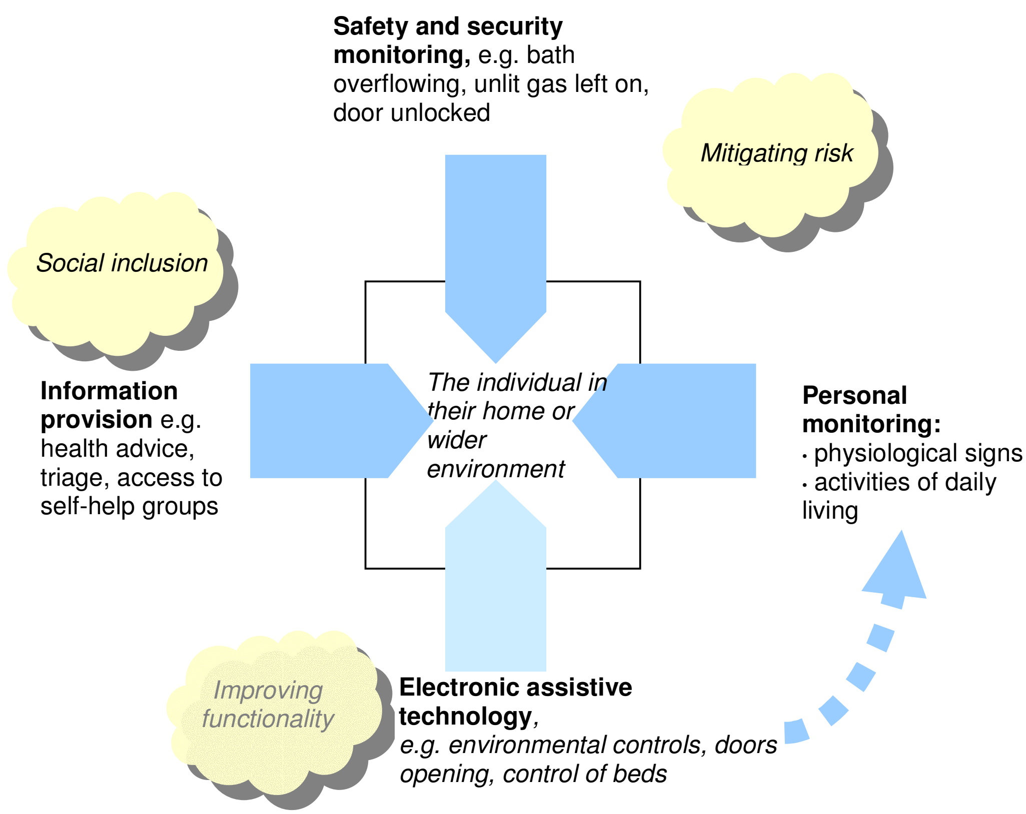
Studying such service innovations in pilot projects gives important insights into their cost and benefits. However, these pilot projects are limited in the extent to which they can give reliable indications of the systemic impact of the implementation of the service innovations. Moreover, the introduction of a service innovation in care delivery is likely to only gradually change the system – sudden complete change from one system to another is neither feasible nor likely. Understanding the time dimension of implementation and the time required for changes to become effective is therefore important. Similarly, the distribution of cost and benefits between different institutions and individuals, and influences on other parts of the care system (and at later times), cannot be captured if innovations are studied in isolation.

To understand these consequences of service innovations on the level of a local care economy over time we have used a system dynamics approach.

Background – telecare

Telecare involves the delivery of health and social care to individuals within the home or wider community, with the support of systems enabled by information and communication technologies (ICT). It can be distinguished from telemedicine, which involves applications to support the exchange of information between health care professionals. Telecare is based on the premise that people in need of care should be able to participate in the community as much as, and for as long as, possible. Care should therefore be deliverable where it is most appropriate and potentially anywhere in normal physical environments. At different times this may be at home, in 'lower intensity' residential care settings or on a mobile basis in the normal daily living environment.

A typical telecare service involves a system connecting sensors in dispersed homes or worn by the user to a call centre. The sensors are activated in case of need, for example following a fall or an overflowing bath, and elicit a response by the alarm service, involving informal carers or mobile staff as appropriate. In some ways, telecare is simply a development of the existing community alarm services, currently covering over 1.5 million people in the UK, into a more proactive form of monitoring by incorporating passive alarms and sensors which can alert the call centre automatically when hazards arise or if there are other indications for a problem such as a significant lack of activity of the user. More advanced telecare services might be linked to electronic assistive technology (e.g. environmental controls). Other forms of telecare include the provision of health information.



Telecare therefore provides a service that can be remotely delivered and is location independent. It is flexible and expandable to meet changing individual needs. It fits into a care package derived from an individual assessment of need which can include domiciliary care, assistive technology and home nursing care.

A major function of telecare is to enable older and disabled people to remain in their own homes by providing increased safety and reassurance to them and their carers. Telecare thus has important implications for the future location of care delivery because it can potentially transform a previously unsuitable environment into one that is sufficiently safe for a patient to be discharged to or remain in as their condition changes. Proponents of telecare have high hopes of the potential of ICT supported care delivery to transform the care system, slow the increase in the cost of care delivery while preserving the independence of elderly people in their own homes. Particular expectations include a reduction of the cost of care provision, the prevention of unnecessary admission to institutional care as well a beneficial effect on the maintenance of health (through the earlier detection of signs of deterioration and appropriate action). It is not only hoped that telecare will reduce the need for nursing and residential care provision, but also that it will reduce the need for hospital care by avoiding hospitalisation (through the early detection and management of crises in the community) and through a speedier, but safe discharge back into the community.

In the UK, government policy is playing a direct part in stimulating interest in telecare. Of particular significance are the moves since the early 1990s towards increased care provision outside the institutional context. This is partly a result of a concern to provide people with greater choice over their care pathways and partly because of moves to contain the cost of providing care. The majority of older people prefer to remain in their own homes for as long as possible and residential or nursing home care is viewed very much as the choice of last resort (Henwood *et al.,* 1998; Smith *et al.,* 1993). The typical care and housing pathway for older people – from mainstream housing to sheltered housing or residential care and eventually to hospital and/or nursing care – has been widely criticised (Royal Commission, 1999). A move away from this approach is seen as desirable.

Because of its ability to mitigate the risk of individuals living in the community when they would otherwise be in institutional care, there is substantial interest by the UK government in the opportunities telecare may offer (Department of Health, 2001a-c). Even though the expectations for the benefits of telecare are high, actual experience (Roush, 1995; Wootton *et al.*, 1998; Balas and Iakovidis, 1999) of (mainstream) service delivery through telecare remains scarce (Barlow *et al.*, 2004). While trials of telecare services suggest substantial benefits at the individual level, the understanding of the effect of the introduction of telecare on the system level is more limited. Telecare has generally been evaluated with a view to exploring clinical outcomes rather than systemic impacts. Available data from trials of specific telecare services in specific situations with specific (and sometimes only vaguely defined) patient groups might not give more than an indication for the potential effects of telecare in other settings and even less so its systemic implications. In addition, the base line, i.e. the current system of service delivery is also only partially understood. In particular, evidence of the change in health status of people in the community over time is mostly anecdotal.

Research approach

This paper aims to examine these expectations for the impact of telecare. In particular we want to investigate how realistic the hopes placed in telecare are in the short-term to medium-term (i.e. over 5 years).

Clearly the data available to answer these questions is not as plentiful and of as high a quality as would be desirable. However, system dynamics has often succeeded in gaining valuable insights even in situations where the available data has been quite limited. Indeed, its ability to develop an understanding of the behaviour of a system based on the structure of the system and only approximate parameter values is one of the key strengths of this approach. However, it is necessary to be careful not to turn this methodological strength into an application weakness by inappropriate neglect of data. Homer (1996, 1997) rightly emphasises how structure and policy conclusions can depend on adequate use of data.

We have therefore to establish to what extent in our case the limited data allows a judgement on the systemic impact of telecare to be made. Sensitivity analysis is required in order to ensure that insights into fundamental relationships, system behaviour and policy conclusions derived from our model are robust.

Previously, system dynamics has been used for the study of policy issues in the provision of health and social care for the elderly (e.g. Wolstenholme, 1993 and 1999, Linard, 1996, Walker and Haslett, 1999). In some of this work the availability and quality of data was severely restricted. In their system dynamics work on care services for the elderly, Wolstenholme (1993 and 1999) and Linard (1996) have shown that insights can be gained from structural analysis and estimates of some parameters. Related work on care for patients with chronic illnesses is also relevant (Homer *et al.*, 2003)

We have carried out this modelling work as part of a larger research project (funded by the UK Engineering and Physical Science Research Council) on telecare implementation. This project brought together a local health trust, a social services department and a range of industrial partners. The project evaluated the implementation of a telecare scheme for frail elderly people, examined organisational barriers to telecare implementation and explored the wider implications of mainstream telecare deployment using a combination of scenario building and simulation modelling. Primary data as well as the views of the various stakeholders for a (potential) telecare implementation process were collected through a range of workshops and in interviews.

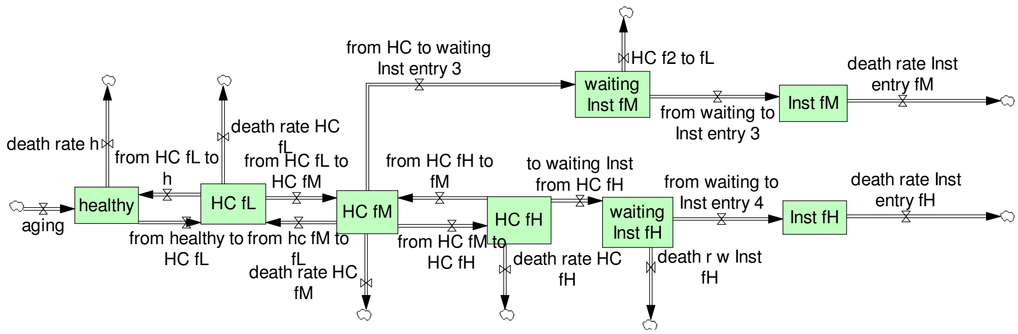
A system dynamics model of care delivery

The starting point of our system dynamics work is a highly aggregated, simplified description of the main patient/client flows in the system before the implementation of the telecare innovation.

Elderly people enter the model as they reach the age of 65 (first stock in the model). After some time, some of these elderly people will become frail and require low intensity home care (HC fL); with increasing frailty more intensive home care packages will be required (HC fM, HC fH). Some of the clients of the two higher intensity home care packages are referred on to institutional care (Inst) representing both nursing and residential homes. As the capacities of care homes are limited, a waiting list for institutional care exists. In our model, clients wait in their previous home care setting for new places to become available. Clients/patients leave the system mainly as a consequence of death. The provision of services for clients in different settings incurs costs for the system. Among the clients receiving homecare the model assumes that both deterioration and improvement in frailty is possible. (Figure shows only stock – flow structure; influences on the rates are omitted for readability).

The categorization of elderly people according to their frailty is based on an indicator developed by Arber (1991) and applied to data from the 1997 Elderly Follow-Up Study to

British General Household Survey[1] (Office for National Statistics). (The medium frailty category comprises two of Arber's categories). The possibility of improvement in frailty was included since the available data from the 1997 Follow-Up Study of Elderly respondents to the 1994 General Household Survey shows this to be an important feature. Service use of clients in different frailty categories was derived from the 1994 General Household Survey and costed according to typical 2003 prices (Netten/Curtis, 2003).

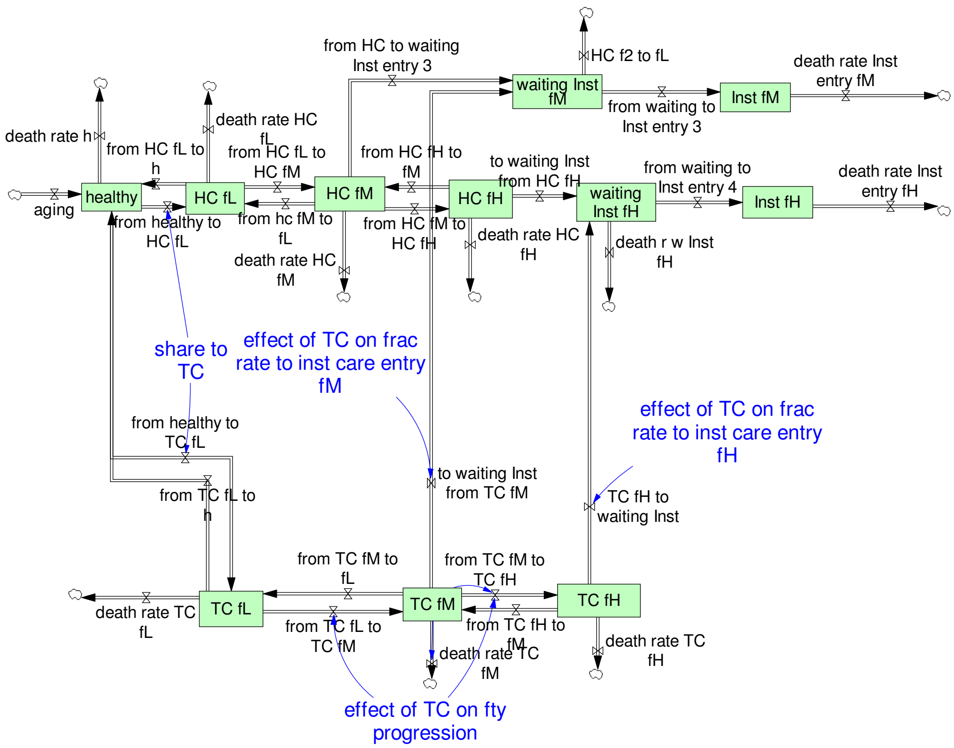


Building on this model, we can then examine the systemic impact of the introduction of telecare. The structure representing telecare is parallel to that of standard home care. We can use the model to explore the consequences of different assumptions about the differences of telecare and standard care provision concerning

- the cost of care provision;
- the impact on the prevention of institutionalisation; and
- the impact on disease progression.

The model allows us to explore the effect of the introduction of telecare under different scenarios, particularly the effect on the number of clients cared for in institutional care and overall cost. We have chosen these two indicators as the most relevant to current care policy and care provider concerns.

[1] Disclaimer note: The original data creators, depositors or copyright holders, the funders of the Data Collections and the UK Data Archive bear no responsibility for their further analysis or interpretation of this data.



The 1997 Follow-Up Study to the General Household Survey 1994 has been used to estimate the size of the stocks of people of different frailty in the community. This national data was then scaled down to the population size of a particular local area (Surrey). However, many parameters in our model are based on estimates. The share of people in each frailty category moving to other categories remains constant. Transition rates have been chosen such that in absence of the introduction of telecare (and without taking into account demographic change) we are in a steady state: elderly people enter the system at the same rate as people leave the system due to death, and the size of the frailty groups at home, as well as the institutional population, remains constant over time. In a first approximation demographic change and the growing number of elderly people can be ignored for the time horizon of 5 years in which we are interested[2]. Nevertheless, it would be desirable to improve the data basis of our model.

The representation of the system with stocks and flows was also helpful to communicate with project partners the implications of different patient routes. To understand the system at the level of patient flows is in principle comparatively easy; in practice the collection of accurate data is a significant challenge.

The dynamics of telecare implementation

Cost-benefit studies of proposed care innovations typically compare the impact of *implemented (and fully effective)* changes with the current system of service delivery. This state is however not reached immediately. For telecare this transition period is likely to be

[2] Demographic change would change the rate with which elderly people enter the system. The increasing life-expectancy after 65 indicates that frailty progression and/or fractional death rates will also be adapted in the long-term to reflect this.

long. For two main reasons many of the benefits of telecare will only become fully effective many years after its implementation.

A complete switch from the current status to a radically changed mode of service delivery cannot happen over night. It is undesirable for existing, particularly frail clients or those already in institutional care to suddenly adapt to a telecare enhanced service delivery in their own homes. Moreover, organisational barriers to implementation have to be overcome; training of staff and development of infrastructure are required, and can only take place over time. Only a gradual shift towards a telecare supported care delivery system is therefore realistic and desirable. This shift will ideally start with those elderly people requiring social services homecare for the first time. For this reason our model allows for a switch to telecare only at this stage.

Telecare changes the rates of entry to institutional care homes, where residents will remain on average for several years. The full impact of the changed admission rates on the size of the institutional care population is therefore only realised long after the switch to the new model of care delivery has been made.

Simulation experiments

Our aim is to examine the likely effect of the implementation of telecare on the population in institutional care homes in the short to medium term in an UK locality. Telecare is expected to change the entry rates to institutional care from community care (from medium and high frailty) and on the progression of frailty. However, as telecare services are still under development, their precise effects on the fractional entry rates to institutional care are uncertain. Similarly it is unclear which people requiring care for the first time will be suited to a care package which includes telecare. This will depend on the telecare services offered in a specific locality. In order to deal with this uncertainty we have performed a range of sensitivity simulations.

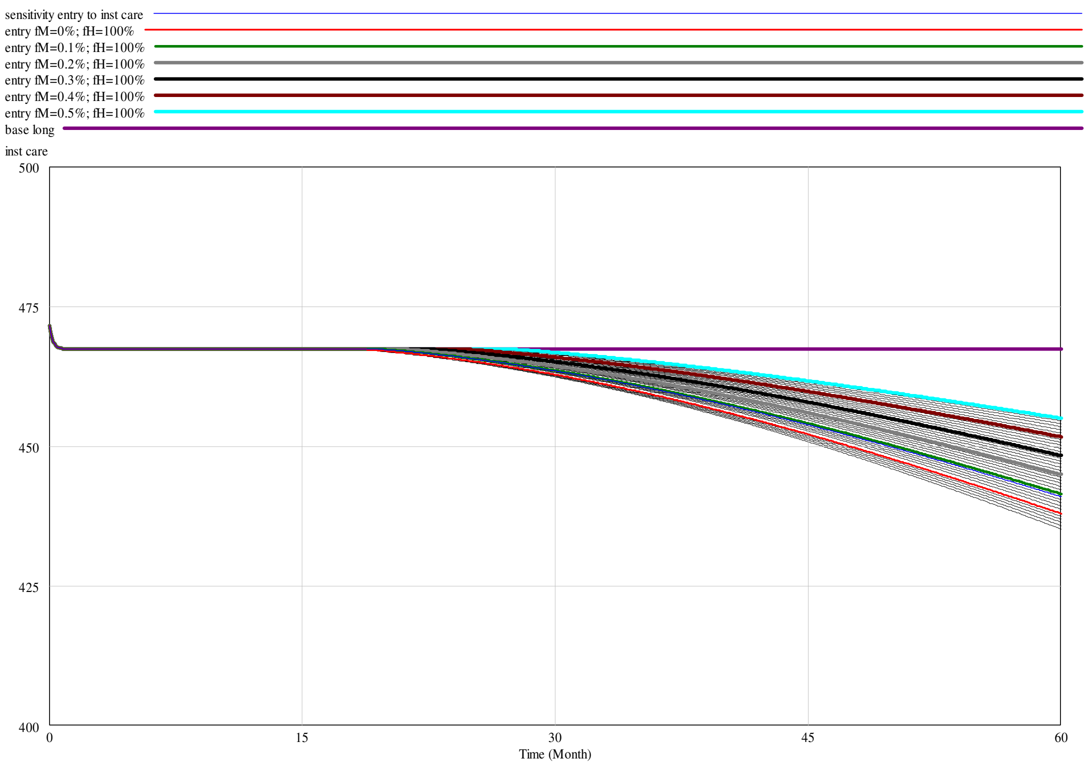
We first look at the sensitivity in the different parameters in isolation and then run a combined sensitivity analysis. Subsequently, we examine the likely financial impact of the introduction of telecare under different assumptions of the cost differences between telecare and conventional forms of care delivery.

Telecare and the entry to institutional care

Telecare helps individuals to avoid the admission to institutional care. The percentage of individuals of medium and high frailty entering institutional care will therefore be lower for those receiving a package including telecare than for those receiving a standard home care package. It can be expected that telecare will be more effective in preventing admission to institutional care from the medium frailty category than from the high frailty category since very frail patients are likely to need either more frequent hands-on help or a quicker response in case of a crisis than can be provided in a home setting without the permanent presence of a carer. For many individuals telecare will therefore *postpone* the admission to institutional care rather than making it entirely *unnecessary*.

We have simulated the size of the institutional population over 5 years depending on the effect telecare has on the entry to institutional care. We have done this under the assumption that telecare has no impact on frailty progression and that 50% of all people requiring care for the first time receive a telecare package.

The figure below shows the size of the institutional population after the introduction of telecare, assuming that the fractional entry rate of medium frail people into institutional care is reduced to 0%, 10%, 20%, 30%, 40% or 50% of the fractional entry rate for non-telecare recipients. The coloured lines assume that telecare has no reducing effect on entry from the high frailty category. The intermediate black lines show the size of the institutional population if telecare also reduces the fractional entry rate from the high frailty category to 50%, 60%, 70 %, 80% or 90% of the fractional rate for non-telecare recipients[3].



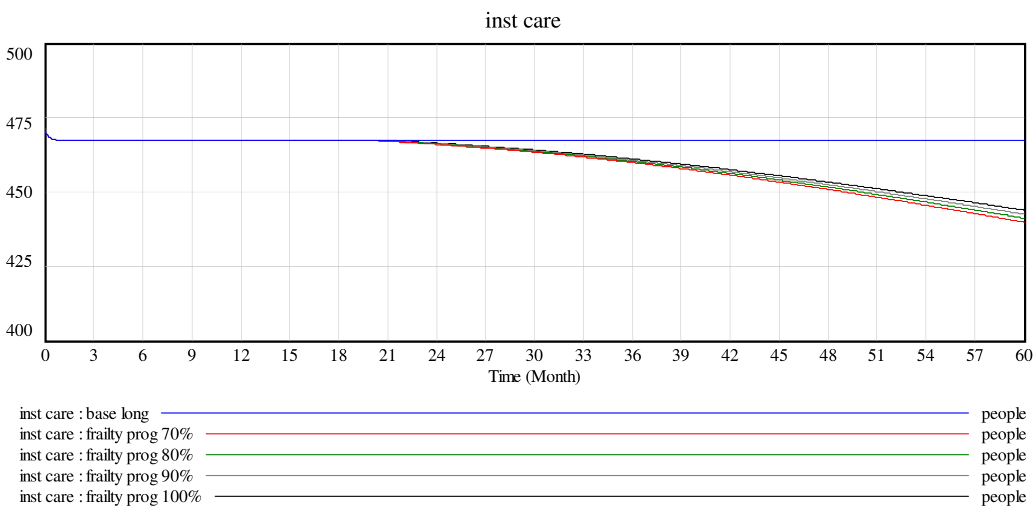
Under the given assumptions telecare reduces the size of the institutional population 5 years after implementation from 467 to between 435 and 455, i.e. a drop of between about 2.5% and 7%. The effect of telecare on entry from the *medium frailty* category is far more important for the size of the institutional population than the effect on entry from the *high frailty* category. This is because there will be virtually no effect on the size of the institutional population until the low frailty patients which first receive telecare become frailer.

[3] The number given in graph refers to the fraction of people of one fragility group with telecare entering the service compared to the standard homecare case. "0.5" for the variable telecare effect on entry FM means therefore that the fractional rate of entry to institutional care from the medium frailty group is in the telecare case half what it was in the standard homecare case.

Frailty progression and its effects

It is hoped that telecare will have some effect on the progression of frailty since an earlier indication of the first signs of deterioration might allow measures to slow this process to be put in place. Following this argument we have conducted a range of experiments varying the effect of telecare on frailty. To do this we assumed that the share of new clients receiving telecare will be 50% and that telecare reduces the fractional entry rate to institutional care from the medium frailty category to 20% and from the high frailty category to 80% of the non-telecare case.

The figure below shows simulation runs with the inclusion of an effect which reduces the rate of progression by 10%, 20% and 30%. These experiments show, however, that the effect on the institutional population will be small (less than 1% of the institutional population).



This explicit effect of telecare on frailty progression is not the only effect it could have on the composition and size of the elderly population. This is because different fractional death rates are associated with the different settings and in particular the death rate in institutional care is higher than the death rate at home. It is unfortunately impossible to say whether the underlying assumptions leading to this effect are correct. This is not only due to the lack of suitable data on telecare, but also due to a lack of understanding of the base case. The data on whether and how morbidity changes in individuals and particularly in an aging population is sparse. While the related debate on the "compression of morbidity" (Fries, 1980; Schneider and Brody, 1983) is inconclusive, there are indeed indications that individuals not only live longer, but also enjoy a healthy life for a longer time (Hessler et al., 2003; Doblhammer and Kytir, 2001). This would therefore lead to a very small increase of the elderly population even if, ignoring demographic change, the number of people reaching retirement age remained constant.

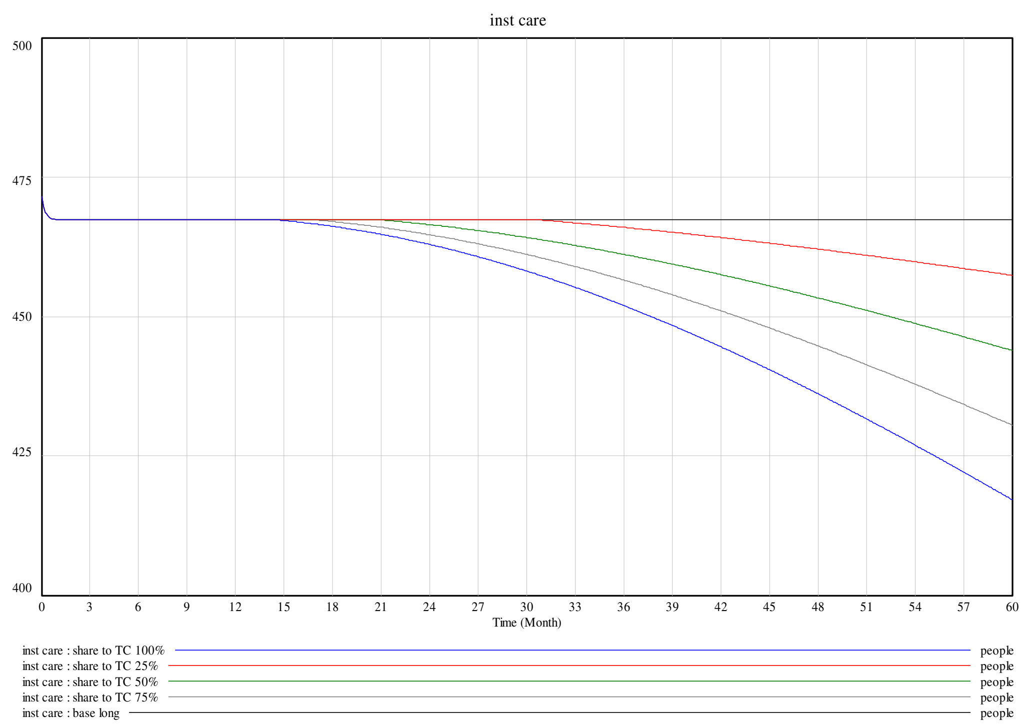
The share of telecare recipients

In a further set of experiments we varied the share of first time care recipients receiving telecare between 0% and 100%. For this set of simulation runs we assumed that telecare reduces entry to institutional care from the medium frailty category by 80% and from the high frailty category by 20%. We further assumed that telecare has no effect on frailty progression.

If we simulate the care system over a period of five years, the model shows that under the given assumptions the drop in the number of people in institutional care is small. Even in the most extreme case, assuming 100% of those now requiring home support will get a telecare enhanced package, the drop in institutional population after 5 years is only about 12%.

Given that not all clients might be suitable, assuming a share of telecare referral of 50% might be more realistic. This leads to a reduction in the institutional population by 6%. The limited effect of telecare on the institutional population is due to the time required for substantial numbers of this cohort of elderly people becoming so frail as to require high intensity care.

However, this discussion has not yet taken into account supply side delays in implementation. The build up of infrastructure, training requirements, local policy and other factors might further reduce the number of people to which telecare services can be delivered initially. This would then further delay the impact of telecare implementation on the institutional care population.

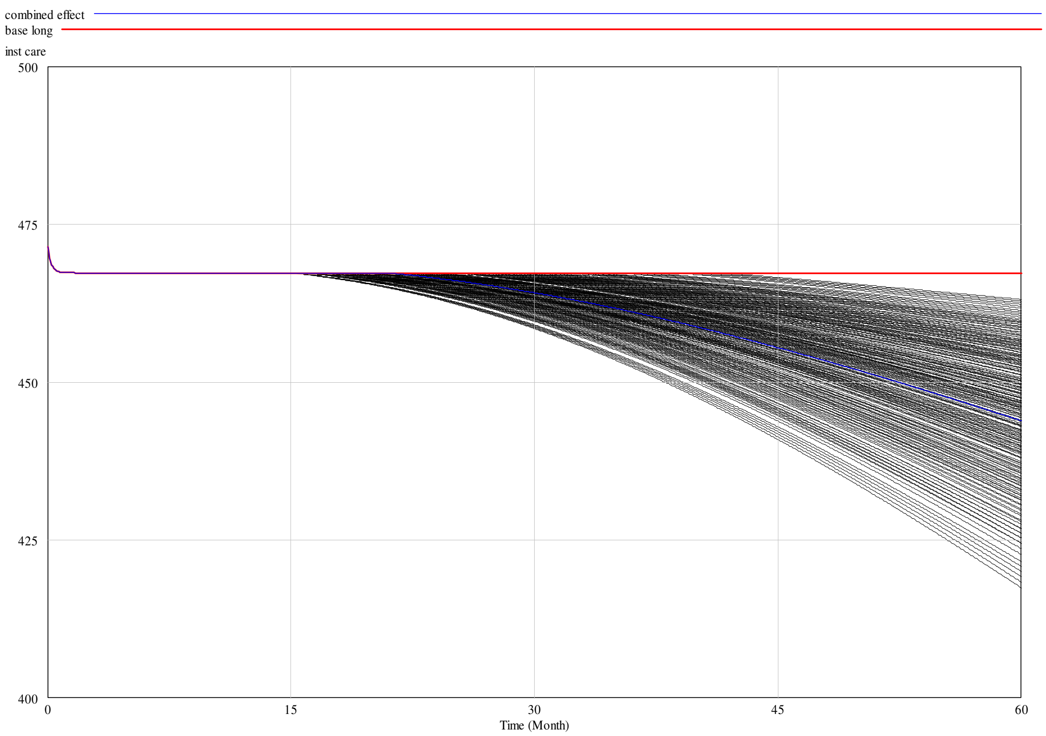


These simulation experiments suggest that an argument for telecare based on the expectation of a short-term reduction in the institutional care population has to be treated with some scepticism. This discussion also shows that static considerations comparing the present state with a future state of care delivery (ignoring the transition time) are less informative for health and social care planning than a more dynamic point of view.

The combined effect

In order to assess the combined effect of different assumptions for all the parameters characterising telecare, we have performed a sensitivity analysis varying the effect on frailty progression between 70% and 100%, the effect on entry from high frailty between 50% and 100% and the effect on entry from the medium frailty category between 0% and 50%. We further varied the share of first time care recipients receiving telecare between 25% and 75%.

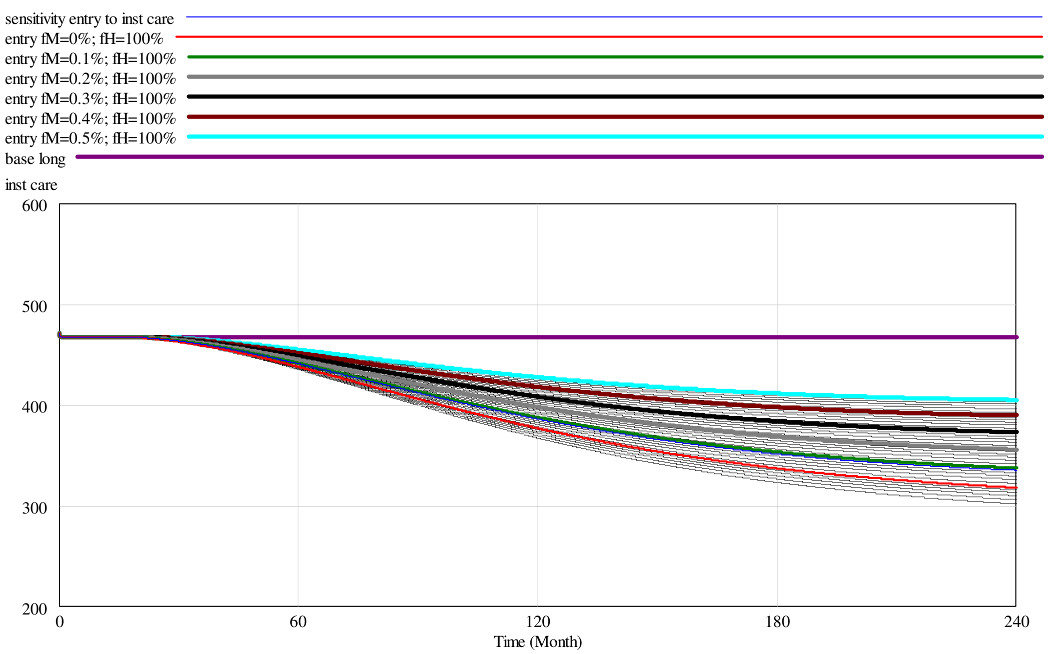
Under the most optimistic combination of assumptions the institutional care population in month 60 will drop by 11% to 417, compared to the non-telecare case. Under the most pessimistic combination of assumptions the drop will be less than 1%.



The long-term effect

In the long-term, the effect of telecare will be far more pronounced. A simulation over twenty years, allowing the care delivery system to get closer to a steady state again, shows a very substantial drop in institutional population. The uncertainty in the parameter values characterising telecare is however such that estimates of the long-term effect on the institutional population are virtually useless. Moreover, as telecare is based on evolving technology its characteristics are likely to change substantially over such a long time period. The graph below shows a set of simulations over twenty years for different assumptions regarding the two key parameters. The effect of telecare on the entry to institutional care from telecare enhanced homecare is varied while the other parameters are kept constant. The coloured lines indicate runs for different values for the parameter describing the effect of telecare on entry from medium frailty categories varying from a reduction to no entries from this category (0%) to a reduction to 50% of the fractional entry rate without telecare.

Nevertheless, the simulation experiments might give an indication in which direction telecare should be developed to have the biggest impact. Even for this very long time period the impact on the institutional care population of reductions in the fraction of entry of telecare recipients to institutional care, is considerably stronger for the case of medium frail telecare recipients than for very frail telecare recipients. This suggests that – at least from this perspective - the focus of the development of telecare services and technology should be on reducing the entry to institutional care from medium, rather than high, frailty groups.



Financial considerations

In a further set of simulation experiments we investigated the cost of care service provision under several scenarios of telecare effectiveness and cost. We assume here that 50% of clients receiving care for the first time receive a package including telecare. We further assume that telecare has no direct effect on frailty progression, but results in a 20% reduction of entry into institutional care for high frailty clients.

We have run this simulation for 60 months for different combinations of telecare cost (compared to standard homecare) and telecare effectiveness (in terms of its effect of entry into institutional care from the medium frailty category). As can be seen from the table below, under these assumptions telecare is only cost saving over 5 years if it is not more expensive than standard homecare. (Any set-up costs are excluded; including these would result in an even more pessimistic assessment.) Hopes that highly effective, but also more expensive telecare services might be cost-saving, appear therefore - at least for the time horizon of most care providers - questionable.

Cost over 5 years telecare case compared with standard care delivery system												
		telecare costs as share of standard homecare costs										
effect of TC on frac. rate to inst care entry fM		**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**
	0.0	-5%	-4%	-3%	-3%	-2%	-1%	0%	1%	2%	2%	3%
	0.1	-5%	-4%	-3%	-2%	-2%	-1%	0%	1%	2%	3%	3%
	0.2	-5%	-4%	-3%	-2%	-2%	-1%	0%	1%	2%	3%	3%
	0.3	-5%	-4%	-3%	-2%	-1%	-1%	0%	1%	2%	3%	4%
	0.4	-5%	-4%	-3%	-2%	-1%	-1%	0%	1%	2%	3%	4%
	0.5	-5%	-4%	-3%	-2%	-1%	0%	0%	1%	2%	3%	4%
	0.6	-5%	-4%	-3%	-2%	-1%	0%	0%	1%	2%	3%	4%
	0.7	-4%	-4%	-3%	-2%	-1%	0%	0%	1%	2%	3%	4%
	0.8	-4%	-4%	-3%	-2%	-1%	0%	1%	1%	2%	3%	4%
	0.9	-4%	-3%	-3%	-2%	-1%	0%	1%	2%	2%	3%	4%
	1.0	-4%	-3%	-2%	-2%	-1%	0%	1%	2%	2%	3%	4%

Conclusions

The limited trials of telecare services have generally been evaluated with a view to exploring their individual clinical outcomes, rather than systemic impacts. The work reported here suggests that an increased emphasis should be put on understanding the systemic impacts of the implementation of service innovations over time. While clearly more research and better data are needed, this paper has given some indications that overly optimistic assessments of the systemic effects of telecare in the short to medium term should be avoided – in the short-term focusing on medium frailty clients and lower cost solutions might be more viable from a policy and clinical effectiveness perspective. The importance of the time dimension of implementation is so strong in the case of telecare for two reasons. First, as we argued earlier, the particular characteristics of this type of care service and its users prevent rapid change. Second, the effects of telecare can only have a delayed impact on the size of the institutional care population since this population will for a long time largely comprise cohorts of elderly people who entered institutional care before the telecare was introduced.

The availability of data remains a limiting factor for not only the model presented here but also for the development of service and business models for telecare for three related reasons. Firstly, there is little reliable data on the scale of the care need in the areas that telecare addresses. Secondly, because of the paucity of evidence for the impact of telecare on resource flows within the care system as a whole. Thirdly, the current lack of rigorous data on the system-wide distribution of costs and benefits inhibits the development of sustainable telecare business models, since potential telecare service providers are unable to make accurate pricing decisions. As more trials are conducted and more evidence is gathered, it should become easier to define more detailed business models.

The data we had available for the modelling in this paper was probably too limited to adequately understand the long-term consequences of telecare implementation. Nevertheless, important insights into the short-term behaviour of the changing system and more generally into the importance of the dimension of time in the implementation process were derived. Since only gradual shifts in the model of care delivery are possible (because of the limited ability of the system to change and the limited abilities of the clients/patients to adapt to change) an essentially static comparison of different models of care delivery is not enough. The benefits (as well as the costs) of any change in care delivery can only be understood if this time dimension is taken into account. Cost-benefit studies of proposed care innovations in which the effect of implemented changes is compared with the current system of service delivery therefore have to be complemented with dynamic considerations of the process of change. In our example the time period of change is long and the time when the change is completed and the benefits of telecare on the system are fully effective is likely to lie outside the time horizon of policy and other decision makers. In the long term the effect of telecare on the size of the institutional population might possibly be substantive, in the short to medium-term this will not be the case. On a restricted time horizon telecare will possibly be financially more viable when benefits in the health care sector (as opposed to the social care sector) are included; telecare might help to reduce hospital admissions and save money in the shorter term. The research reported here focused on social care costs, these considerations are therefore beyond the scope of the research reported; the question of the effects of telecare implementation on hospital costs should be the subject of additional research.

While the importance of the implementation process and its time dimension might seem obvious, the expectations of proponents of innovations and the behaviours of decision makers – and certainly not only in health and social care delivery – testify to the ease with which this can be forgotten in practice.

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Appendix: model (Vensim)

(001) "65+ frac death rate" = 0.00493476
(002) aging = total stable deaths
(003) average length of stay entry 3 = 35
(004) average survival inst 2 = stable inst 2 / stable death inst 2
(005) average survival inst c = 28
(006) capacity Inst = stable inst
(007) CC costs per time period = (HC fL costs per client and month * HC fL + HC fM costs per client and month * HC fM + HC fH costs per client and month * HC fH) * SS share of community care costs
(008) community = waiting in community + TC + HC
(009) Community care costs = INTEG(CC costs per time period , 0)
(010) community care no TC = HC fL + HC fM + HC fH
(011) Community Care with TC costs = INTEG(TC CC costs per time period , 0)
(012) community waiting for institutional care = waiting Inst fM + waiting Inst fH
(013) cost waiting in comm per time period = waiting at home costs per client and month * (waiting Inst fM + waiting Inst fH) * SS share of institutional care costs
(014) death r w Inst fH = waiting Inst fH * frac death rate fH
(015) death rate h = frac deaths r h * healthy
(016) death rate HC fH = frac death rate fH * HC fH
(017) death rate HC fL = frac death r fL * HC fL
(018) death rate HC fM = frac death r fM * HC fM
(019) death rate Inst entry fH = Inst fH / average survival inst 2
(020) death rate Inst entry fM = Inst fM / average length of stay entry 3
(021) death rate TC fH = frac death rate fH * TC fH
(022) death rate TC fL = frac death r fL * TC fL
(023) death rate TC fM = frac death r fM * TC fM
(024) effect of TC on frac rate to inst care entry fH = 0.8
(025) effect of TC on frac rate to inst care entry fM = 0.2
(026) effect of TC on fty progression = 1
(027) FINAL TIME = 60
(028) fit criteria : all h,all fL,all f2,all fM,all fH,age cohort
(029) frac death r fL = 0.003
(030) frac death r fM = 0.004
(031) frac death rate fH = 0.005
(032) frac deaths r h = stable deaths h / stable h
(033) frac from fH to inst = stable from fH to inst / stable fH
(034) frac from fM to inst c = stable deaths inst 1 / stable fM
(035) frac imp fH = 0.01
(036) frac imp fL = 0.01
(037) frac imp fM = 0.01
(038) frac prog fM to fH = stable from fM to fH / stable fM
(039) frag prog fL = stable from fL to fM / stable fL
(040) frag prog h = stable from healthy to fL / stable h
(041) free cap Inst = capacity Inst - used beds Inst
(042) from HC fH to fM = HC fH * frac imp fH
(043) from HC fL to h = HC fL * frac imp fL
(044) from HC fL to HC fM = frag prog fL * HC fL
(045) from hc fM to fL = HC fM * frac imp fM

(046) from HC fM to HC fH = frac prog fM to fH * HC fM
(047) from HC to waiting Inst entry 3 = HC fM * frac from fM to inst c
(048) from healthy to HC fL = frag prog h * healthy * (1 - share to TC)
(049) from healthy to TC fL = healthy * frag prog h * share to TC
(050) from TC fH to fM = TC fH * frac imp fH
(051) from TC fL to h = TC fL * frac imp fL
(052) from TC fL to TC fM = effect of TC on fty progression * frag prog fL * TC fL
(053) from TC fM to fL = TC fM * frac imp fM
(054) from TC fM to TC fH = effect of TC on fty progression * frac prog fM to fH * TC fM
(055) from waiting to Inst entry 3 = MIN (indicated waiting fM to Inst , max inflow Inst entry 3)
(056) from waiting to Inst entry 4 = MIN (indicated waiting fH to Inst , max inflow Inst entry 4)
(057) HC = HC fH + HC fL + HC fM
(058) HC f2 to fL = waiting Inst fM * frac death r fM
(059) HC fH = INTEG(from HC fM to HC fH - death rate HC fH - to waiting Inst from HC fH - from HC fH to fM , stable fH)
(060) HC fH costs per client and month = 0.463
(061) HC fL = INTEG(from healthy to HC fL - death rate HC fL - from HC fL to HC fM + from hc fM to fL - from HC fL to h , stable fL)
(062) HC fL costs per client and month = 0.255
(063) HC fM = INTEG(from HC fL to HC fM - from HC fM to HC fH - from HC to waiting Inst entry 3 - death rate HC fM - from hc fM to fL + from HC fH to fM , stable fM)
(064) HC fM costs per client and month = 0.264
(065) healthy = INTEG(aging - death rate h - from healthy to HC fL - from healthy to TC fL + from HC fL to h + from TC fL to h , stable h)
(066) indicated waiting fH to Inst = waiting Inst fH / minimum filling time
(067) indicated waiting fM to Inst = waiting Inst fM / minimum filling time
(068) INITIAL TIME = 0
(069) inst care = Inst fH + Inst fM
(070) Inst cost per time period = Inst costs per patient and month * (Inst fH + Inst fM) * SS share of institutional care costs
(071) Inst costs = INTEG(Inst cost per time period , 0)
(072) Inst costs per patient and month = 1.79
(073) Inst fH = INTEG(from waiting to Inst entry 4 - death rate Inst entry fH , stable inst 2)
(074) Inst fM = INTEG(from waiting to Inst entry 3 - death rate Inst entry fM , stable inst 1)
(075) max inflow Inst = free cap Inst / minimum filling time
(076) max inflow Inst entry 3 = max inflow Inst * share waiting Inst entry 3
(077) max inflow Inst entry 4 = max inflow Inst * share waiting Inst entry 4
(078) minimum filling time = 0.25
(079) "pop 65+" = 9429.7
(080) rate rel aging[fit criteria] = 0
(081) SAVEPER = TIME STEP
(082) share f2 = 0.15
(083) share fH = 0.028
(084) share fL = 0.23
(085) share fM = 0.07

(086) share h = 0.47
(087) share inst = 0.05
(088) share inst 1 = 0.8
(089) share to TC = 0.5
(090) share waiting Inst entry 3 = IF THEN ELSE ((waiting Inst fM + waiting Inst fH) > 0, waiting Inst fM / (waiting Inst fM + waiting Inst fH) , 0)
(091) share waiting Inst entry 4 = 1 - share waiting Inst entry 3
(092) SS share of community care costs = 0.5
(093) SS share of institutional care costs = 0.5
(094) stable death inst 2 = stable deaths inst - stable deaths inst 1
(095) stable deaths fH = stable fH * frac death rate fH
(096) stable deaths fL = stable fL * frac death r fL
(097) stable deaths fM = stable fM * frac death r fM
(098) stable deaths h = total stable deaths - stable non healthy deaths
(099) stable deaths inst = stable inst / average survival inst c
(100) stable deaths inst 1 = stable inst 1 / average length of stay entry 3
(101) stable fH = share fH * "pop 65+"
(102) stable fL = "pop 65+" * share fL
(103) stable fM = "pop 65+" * (share fM + share f2)
(104) stable from fH to fM = frac imp fH * stable fH
(105) stable from fH to inst = stable deaths inst - stable from fM to inst
(106) stable from fL to fM = stable from healthy to fL - stable from fL to healthy - stable deaths fL + stable from fM to fL
(107) stable from fL to healthy = frac imp fL * stable fL
(108) stable from fM to fH = stable deaths fH + stable from fH to inst + stable from fH to fM
(109) stable from fM to fL = frac imp fM * stable fM
(110) stable from fM to inst = frac from fM to inst c * stable fM
(111) stable from healthy to fL = total stable deaths - stable deaths h + stable from fL to healthy
(112) stable h = "pop 65+" * share h
(113) stable inst = share inst * "pop 65+"
(114) stable inst 1 = stable inst * share inst 1
(115) stable inst 2 = stable inst - stable inst 1
(116) stable non healthy deaths = stable deaths fL + stable deaths fM + stable deaths fH + stable deaths inst
(117) sum of clients = community + inst care
(118) sum of elderly = healthy + sum of clients
(119) sum of shares = share fL + share f2 + share fM + share fH + share h + share inst
(120) TC = TC fH + TC fL + TC fM
(121) TC CC costs per time period = (TC fL costs per client and month * TC fL + TC fM costs per client and month * TC fM + TC fH costs per client and month * TC fH) * SS share of community care costs
(122) TC costs as share of standard HC costs = 0.9
(123) TC fH = INTEG(from TC fM to TC fH - death rate TC fH - TC fH to waiting Inst - from TC fH to fM , 0)
(124) TC fH costs per client and month = HC fH costs per client and month * TC costs as share of standard HC costs
(125) TC fH to waiting Inst = TC fH * frac from fH to inst * effect of TC on frac rate to inst care entry fH

(126) TC fL = INTEG(from healthy to TC fL - death rate TC fL - from TC fL to TC fM - from TC fL to h + from TC fM to fL , 0)
(127) TC fL costs per client and month = HC fL costs per client and month * TC costs as share of standard HC costs
(128) TC fM = INTEG(from TC fL to TC fM - from TC fM to TC fH - death rate TC fM - to waiting Inst from TC fM - from TC fM to fL + from TC fH to fM, 0)
(129) TC fM costs per client and month = HC fM costs per client and month * TC costs as share of standard HC costs
(130) telecare = TC fL + TC fM + TC fH
(131) TIME STEP = 0.0625
(132) to waiting Inst from HC fH = frac from fH to inst * HC fH
(133) to waiting Inst from TC fM = effect of TC on frac rate to inst care entry fM * frac from fM to inst c * TC fM
(134) total costs = Community care costs + Community Care with TC costs + Inst costs + waiting in comm costs
(135) total stable deaths = "pop 65+" * "65+ frac death rate"
(136) used beds Inst = Inst fH + Inst fM
(137) waiting at home costs per client and month = 1.79
(138) waiting in comm costs = INTEG(cost waiting in comm per time period , 0)
(139) waiting in community = waiting Inst fH + waiting Inst fM
(140) waiting Inst fH = INTEG(to waiting Inst from HC fH + TC fH to waiting Inst - from waiting to Inst entry 4 - death r w Inst fH , 0)
(141) waiting Inst fM = INTEG(from HC to waiting Inst entry 3 + to waiting Inst from TC fM - from waiting to Inst entry 3 - HC f2 to fL , 0)