A systematic review of health service interventions to reduce use of unplanned health care in rural areas

Abstract

Rationale and Objective

Use of unplanned health care has long been increasing, and not enough is known about which interventions may reduce use. We aimed to review the effectiveness of interventions to reduce the use of unplanned health care by rural populations.

Methods

Systematic review. Scientific databases (Medline, Embase and Central), grey literature and selected references were searched. Study quality and bias was assessed using Cochrane Risk of Bias and modified Newcastle Ottawa Scales. Results were summarised narratively.

Results

2708 scientific articles, reports and other documents were found. After screening, 33 studies met the eligibility criteria, of which eight were randomised controlled trials, thirteen were observational studies of unplanned care use before and after new practices were implemented, and twelve compared intervention patients with non-randomised control patients. Eight of the 33 studies reported modest statistically significant reductions in unplanned emergency care use while two reported statistically significant increases in unplanned care. Reductions were associated with preventative medicine, telemedicine and targeting chronic illnesses. Cost-savings were also reported for some interventions.

Conclusion

Relatively few studies report on unscheduled medical care by specifically rural populations, and interventions were associated with modest reductions in unplanned care use. Future research should evaluate interventions more robustly and more clearly report the results.

Introduction

The use of emergency and unplanned care in developed countries has long been increasing [1-3]. For instance, emergency hospital admissions in England rose by 32% over 14 years, from 4 million/year in 1998/99 [4] to 5.3 million in 2012/13 [5]. From 2001/02 to 2012/13 there was a 26% increase in emergency hospital admissions for potentially avoidable conditions such as ear or urinary tract infections [5]. The annual total number of emergency calls to English ambulance services rose from 5.6 million in 2004/05 [6] to 9.08 million in 2012/13 [7], a 62% growth over eight years. The causes of these rises are contentious, with interest concentrated on 'inappropriate' attendances [8-10] and whether changes in provision of primary care may be spurring demand for unplanned care [2,11,12]. Ageing populations in many countries [2,13,14] are expected to impose still greater burdens on the urgent care system in the future.

Rural Health

Compared to urban populations, health outcomes in rural communities in developed countries are affected by longer travel distances using less well-maintained infrastructure [15], less exposure to and participation in disease prevention programs [16], delayed disease diagnosis [17], confusion about access to urgent care [18,19], reduced choice of providers and treatment plans [16,20-23], and less support for people managing chronic illness and their carers [15,16,24-26]. Rural residents may have higher costs of living and limited employment opportunities in some areas, but undoubtedly some costs in rural areas are likely to be less than they are for urban communities. Rural populations tend to relatively economically deprived and health-disadvantaged compared to urban groups in the USA [27] or Australia [28], but within Europe, rural communities tend to be more affluent on average with reduced uptake of government benefits [29]. This has led to concerns within Europe that overall affluence can hide poverty [30,31] and ill health in vulnerable rural individuals [32,33].

Objectives of this review

This review aimed to determine which, if any, health service interventions reduce use of unplanned health care by rural populations. Previous reviews [9,34] considered which interventions were most successful at reducing use of unplanned care by the whole population

(combined urban and rural), but interventions addressing only rural residents have not been previously studied. We defined "unplanned" use of health care to include all care sought without advance appointments, such as visits to hospital emergency departments, unscheduled hospital admissions, drop-in clinic visits, emergency transport or mobile medical staff call outs and use of out-of-hour GP services. This wide perspective is especially important in the context of British health care provision. The National Health Service in the UK is a taxpayer-funded universal health service that provides the vast majority of health care [35], including multiple forms of unscheduled care such as emergency departments, emergency transport by ambulance, out-of-hours appointments and unplanned home visits. From the perspective of NHS provision, reductions in any form of unplanned health care use are potentially beneficial and there are net system gains if more expensive forms of unscheduled health care can be reduced, even if as a consequence, demand for other types of unplanned care may rise.

Methods

Protocol

The review protocol was registered with the PROSPERO International prospective register of systematic reviews at the University of York in July 2014 (ref. no. = CRD42014010508). Search terms were developed and tested using the Medline and Embase archives and undertaken in three scientific databases from 1984 to April 2014 (MEDline, Embase and Central) and in 22 grey literature sources. References of background policy documents and eligible studies were screened to check for further articles to include.

"Remote" was treated as a synonym for rural only when it denoted locations away from urban development, and not just physically removed from the care provider. The intervention had to be provided by health services (qualified health professionals), which meant that initiatives such as road speed limits or safety regulations in the workplace were excluded. No restrictions were placed on study design, patient characteristics or language. Studies were restricted to populations living in OECD member nations to ensure comparability of health service provision. We use the terms urgent, unscheduled and unplanned as applied by the original researchers and otherwise as interchangeable.

Study Eligibility and Quality Assessment

Included studies had to feature all of these aspects:

1) Rurality (rural or remote);
2) Mention of an event (admission, incident, appointment, episode, care provided, treatment, assessment etc.)
3) Urgent adjective for the event (unscheduled, urgent, unplanned or emergency)
4) Intervention plan or practices (with measured impact on demand for urgent care)
5) Study design that indicated comparators, such as randomized controlled trial, case series, case controls, etc.

One researcher initially screened all scientific articles for inclusion criteria, with a 20% sample verified by a second researcher for consistency; initial agreement between screeners was 93.7% and disagreements were resolved by discussion. Reference lists of review and policy documents identified from grey literature that had passed through initial screening were then checked for further articles that might meet our inclusion criteria. Standard format tables were used for data extraction. These described baseline characteristics, study outcomes, risk of bias and study quality which were generated, initially by one researcher and verified by a second author, with differences resolved by discussion. Risk of bias assessment was undertaken using Cochrane criteria [36] for randomised controlled trials and a modified Newcastle-Ottawa Scale [37] for other studies. Heterogeneity of interventions and study design meant that meta-analysis was not possible, so a narrative analysis was undertaken.

Figure 1. *PRISMA Diagram of Search and Study Selection Procedure*

Results

The search process is illustrated in Figure 1. 1418 unique scientific articles were found, plus 1290 (sometimes duplicated) reports and other documents from grey literature. Full search operations and results are reported in supplemental tables S1-S2 for scientific literature and S3 for grey literature. 27 scientific articles were included from the scientific literature search and five reports came from grey literature. One item [38] was found from screening references of other reviews on unplanned care use. Therefore a total of 33 articles were included. All final

selected articles were written in English as no other language articles met the inclusion criteria. Studies were undertaken in the USA, Australia, UK, Canada, Japan and Germany. Over 70% of studies monitored for possible change in demand for at least 12 months either after or concurrent with the intervention. Participant groups tended to be large (dozens or even hundreds of consultations or treatment opportunities).

Table 1 about here

Study characteristics

All selected papers mentioned use of unplanned care as an outcome measure. The most common outcomes were visits to accident & emergency departments (n=10) and unscheduled hospital admissions (n = 14; Table 1). Most studies featured patients of any age, six targeted children and seven were focused mostly or entirely on older adults.

There were 33 articles describing 31 research projects. Thaker et al. [39] and Sabesan and Brennan [40] gave similar results from the same Australian telemedicine program at different points in time, while conclusions were available from two sources about the same "virtual wards" program in south western England [41,42]. All other included articles described unique projects.

Risk of Bias

High risk for performance bias was determined for a majority of RCTs, because it was apparent that participants would know which arm of the trial they were in. Risk of bias was often uncertain for randomisation procedures (selection bias), due to inadequate information supplied in the article (Supplemental Tables S4 and S5). Risk of bias ratings for studies only reported in conference abstracts tended to be unclear in all domains in spite of our efforts to contact the authors for further information, demonstrating how difficult it can be to find useful information in such brief reports for the purposes of a systematic review. The equivalent forms of bias (Newcastle Ottawa Scale indicators) for non-RCTs were less likely to be high or unclear. Among non-RCTs, high bias was most likely to result from how comparison groups were treated and there was some indication (high risk) of incomplete data reporting.

Study Design

Eight RCTs were included in the review while 25 non-RCTs either monitored possible changes in unscheduled care use before or after new practices were implemented, or between an intervention group and matched non-randomised controls. Eight studies (one RCT [55] and seven non-RCT design) reported statistically significant reductions in unplanned care use. Table 2 lists these studies with their clinical impacts. Four of the non-RCTs reported no statistically significant reductions in unplanned care use. The remaining 14 non-RCTs mostly focused on pragmatic aspects of pilot studies and although they usually reported reductions in unplanned care use, they did not comment on possible statistical significance.

Health conditions and strategies employed to reduce use

Intervention strategies were diverse although similar elements were often in both the most and least successful interventions. In the following discussion interventions were categorised as self-management and case-management, specific conditions, telemedicine (including remote support by specialists of local health care professionals), acute presentations and other. Some studies fall into more than one of these categories.

Self-management and case-management

Twelve papers described programs that teach patients how to better self-manage long-term illness, which included diabetes [43], heart failure [44-46], COPD [47], mental illness [48-50], and asthma [51-54]. In one of the heart failure studies [44, an RCT], patients had statistically significant increased numbers ($p=0.01$) of unscheduled medical appointments, possibly due to increased patient anxiety about signs of deterioration in an intense case management scheme. In two of these self-management studies (on COPD [47] and asthma [52]) there was statistically significant reduced use of unscheduled care ($p < 0.05$). The other nine papers did not report statistically significant results about changes in usage of unplanned care.

Six papers were concerned with optimal case management of and routine treatment for chronically ill ("high risk") individuals in the community [41,42,55-58]. One of these was the only RCT included in the review that reported statistically significant reduced use of emergency care [58], but it also had high or unclear risk of bias in all domains (Supplemental Table S4). The other 5 showed no significant reductions. The 'Virtual Wards' project in

England also illustrates contrasting views on the same programme. The Kings Fund [55] reported an impressive ~20% reduction in emergency admissions from patients in the highest risk groups (before and after intervention was implemented). Yet, comparison was made with high risk patients not part of the Virtual Wards programme and their admission rate was not statistically different from the intervention group. In a more detailed analysis of the same intervention over a longer period and using nationally matched case controls, the Nuffield Trust [41] concluded that the intervention group did not have significantly fewer visits to A&E and that overall, the Virtual Wards project was not highly cost effective compared to usual care.

Specific conditions

Two studies addressed cancer treatment [39,40,59], reporting how routine monitoring or treatment in the community might prevent use of emergency medical care, but did not achieve significant decreases in usage of unscheduled care Three reports described management of other specific risks or problems: attempted suicide [60; significant reductions in usage achieved], acute burns [61, achieved significant reductions in emergency transport] and complications after discharge from hospital [62, reductions in usage not significant]. Four studies [38,63-65] described interventions that addressed unscheduled treatment needed for unspecified conditions of any severity; only one of these [38], which described provision of low cost walk-in clinics, led to a significant reduction in usage of unscheduled care. One article addressed major trauma [66; significant reduction achieved] while two articles [67,68] focused on relatively minor or potentially self-limiting problems such as burns, eye infections, cystitis and other ambulatory conditions (neither achieved significant reductions in usage of unscheduled care). Two studies [38,64] reported on changes in unplanned care use associated with alternative types of service provision (such as walk-in centres, ad-hoc telephone consultations and community clinics), with no significant fall seen in the UK [64] but a significant decrease in unplanned care use in the USA [38].

Telemedicine

Thirteen articles [39,40,45,46,48,49,59,61,65-69] described telemedicine interventions. One telemedicine service offered for routine care was unexpectedly utilised for urgent presentations [39,40] and observed to reduce emergency transfer and hospitalisation. In three projects [46,59,69] it was hoped that technology used to remotely monitor chronic conditions in

individual cases would lead to less usage of unplanned care, but results were mixed. Technology reduced unscheduled hospital visits in a group of children on home-ventilators ($p < 0.05$) [69], without significant increases in other urgent care measures. Combined total scheduled and unscheduled clinic visits were reduced significantly ($p < 0.001$) while unscheduled visits significantly *increased* ($p=0.009$) in a heart failure application of telemedicine [46]. A third study [59], employing tele-monitoring and tele-prompting of American military veterans with cancer, reported more visits to emergency departments in the intervention over control group (p-values not available).

Acute presentations

Three projects [49,63,67] implemented triage protocols to assess immediate medical needs (or lack thereof) from unplanned presentations, and patients were often referred to other providers. No statistically significant reductions were found. Seven studies [48,49,61,65-68] enabled immediate local assessment and treatment by staff who were not specialists in emergency care but acting under the guidance of suitably qualified but remotely located emergency experts. Statistically significant reductions in use of unscheduled care were achieved in only two [61,66] of these seven studies. In most of the telemedicine applications, unplanned care was still sought and received, but the costs for providing care were believed to be lower than an alternative protocol of transport to, assessment at and treatment at a large hospital emergency department.

Other: concern to not increase usage

Two articles describe interventions that were not so much intended to reduce unscheduled care but rather were concerned not to increase it [56,70]. These papers assessed the safety and reliability of treatment or care by non-expert staff which normally would have provided by a more qualified professional. The outcome measures were whether emergency presentation, incorrect diagnosis or treatment or follow-up presentation for the same condition was more likely depending on whether original diagnosis or treatment was made by a health care assistant, non-emergency specialist (general practitioner), remotely located emergency specialists or on-site emergency-specialists. Both studies found no evidence of increased urgent treatment after care by any type of professional.

Benefits besides reduced use of urgent care

In most of the telemedicine applications, unplanned care was still sought and received, but the costs for providing care were believed to be lower than an alternative protocol of transport to, assessment at, and treatment at a large hospital emergency department. Stated per patient estimated cost savings in preventing emergency transport or transfers were Canadian $300 (US $326 at August 2015 prices) [48], Canadian $5350 (US $5425) [65] and UK £929 (US $2210.19) [67]. These cost-savings were calculated as the cost to transport plus cost to treat at emergency centre minus the cost to treat using telemedicine. Total savings in one multi-centre telemedicine project were calculated at Australian $320,118 (US $340,370) [39], although not every centre in the project had net savings. In the context of the Canadian, UK and Australian health systems, these savings per patient or per project were considered by the study authors to be substantial and justified continued service provision. Net cost savings were claimed but not specified in two studies [56,57], while some articles other reported valuable and usually statistically significant intervention benefits (at $p \leq 0.05$) such as earlier warning of clinical decline [46], reduced number of scheduled clinic visits [46] or reduced days of bed care in hospital [59].

Discussion

There was little high quality research assessing interventions to reduce unplanned healthcare use by rural residents. Weak evidence from eight studies (one RCT and seven non-RCT design) showed statistically significant reductions in unplanned care use. Three of these articles were concerned with management of chronic illness (asthma, COPD and generic), three were telemedicine articles (respiratory failure, advice about burns treatment or suspected major trauma and reduction in suicide risk), and one described affordable price community health clinics that provided preventative care to an otherwise underserved population. The majority of the other 25 articles reported reductions in use of unplanned care which lacked statistical significance, which often wasn't tested for at all. Intervention elements and strategies were often similar across both statistically significant and non-significant articles making it difficult to identify which intervention strategies were most successful, although programs that promoted self-management of chronic illness, increased access to services and telemedicine often reduced use. Incomplete reporting was a problem among some of our included reports

which were only available as conference proceedings (in spite of our efforts to find follow-up publications). More rigorous study designs (e.g. randomised controlled trials), more effort to make statistical comparisons, and more detailed evaluation of services that tend to be only described in conference proceedings would be desirable in future research.

Recurring problems with delivering rural health care that have been identified in other literature also surfaced in our review. For instance, in an education program for COPD in a small town (population = 5260) [47], it was noted that most participants came from within the town and not from the surrounding rural region, consistent with claims that rural residents tend to participate less often in health promotion programs [16]. Poor support networks for rural elders with chronic illness is often mentioned in commentaries on rural health [20,71-75], and was touched upon in our included studies [56,58]. Other obstacles were described, such as reluctance by emergency services staff to implement even a quite brief (and ultimately ineffective) preventative asthma intervention [51]. This reluctance by emergency staff to provide preventative education may be unfortunate in the rural context, because some rural groups (eg., agricultural workers) are very low users of primary care, so the only opportunity to promote preventative health management to these populations may be during their contact with emergency services [20,72-74]. More positive results were found in many telemedicine reports which cited an increase in treatment options for rural communities as an important benefit [65,66] that redresses problems of limited treatment options and service provision in rural communities [20,71-74]. The review found no evidence that touched upon grossly inappropriate presentations or that implicated poor access to out-of-hours consultations with family doctors.

Our findings about which interventions work for rural populations are broadly in agreement with findings of other reviews of unscheduled medical care for combined urban and rural populations. Three relevant and recent systematic reviews considered interventions on combined urban and rural populations. Purdy *et al* [76] concluded that the following factors may reduce unplanned hospital admissions: preventative education, especially in self-management, interventions that address heart failure, rehabilitation, telemedicine, exercise promotion, and continuity of care. Huntley *et al* [77] found that continuity of care interventions may reduce unplanned admissions. Ismail *et al* [9] concluded that walk-in centres, out-of-hours GP access and telephone triage in primary care had negligible impacts on demand for unscheduled care, but that emergency nurse practitioners in community primary care may

reduce such demand. Our review, with a focus on usage by rural residents, finds no evidence to contradict the conclusions of these other reviews. It seems likely that most interventions suitable for urban populations will also be effective for rural communities.

Limitations

The inclusion of broad categories of unscheduled care use (not just attendances and presentations to the emergency department) is a strength of the review, but this wide definition also precluded assessment using meta-analysis. Some implemented interventions may never have been considered for publication and as a consequence their results cannot contribute to our review. We searched for under-evaluated and under-reported interventions in grey literature but found relatively few items. More studies should be rigorously reported and evaluated. Publication bias may also have impacted our findings.

We do not consider how the needs of health care needs or problems of rural populations may vary by country. Most of our studies came from North America, Japan or Australia where rural populations generally have lower socio-economic status and poorer health outcomes than urban communities. This is in contrast to the UK or Germany where rural populations are mostly more affluent than the national average. There were insufficient studies to draw strong conclusions, but there was no apparent difference in how well interventions worked whether the location was UK/Germany or USA/Japan/Australia. A more important difference rather than socio-economic status reversal, or even different formats of health service provision, may be the distances involved when telemedicine interventions are employed in each country. The USA and Australia are continental wide with potentially vast distances to cover when transport is required. The potential cost-savings from telemedicine in these locations are probably much higher than for Japan/Germany/UK. Conversely, the high density of population and health care facilities in the latter countries may reduce risks associated with experimental protocols to not immediately transport patients, because if it's decided that a visit to the emergency department is required after all, it's not too far to go. It is beyond the scope of this paper to assess the many possible risk balance trade-offs involved in such intervention planning.

The review only briefly discusses other types of desirable outcomes besides demand for unscheduled care. Our analysis determined risk of bias, and not many other indicators of study quality that have been suggested but are rarely reported in systematic reviews (a long if still not exhaustive list of candidate quality indicators is in Deeks *et al* 2003).

Conclusions

Our review on rural residents broadly concurs with other reviews on combined urban-rural populations that targeting chronic illnesses management, telemedicine and community health clinics may be effective at reducing emergency presentations. It is useful to establish that interventions that work well in combined urban-rural populations seem to also be effective in the rural subgroup alone. Telemedicine was most consistently reported as effective at reducing unplanned care use or expensive emergency transport, particularly when it brought specialist skills to remote locations[61,65-67]. Due to the higher travel costs and travel distances to health care facilities, it seems likely that telemedicine will continue to be especially cost-effective in rural areas.

Due to ageing populations and corresponding rises in chronic illness [2,3,13,14], the demand for unscheduled health care is likely to continue to rise in developed countries. It is argued [10] that interventions to reduce demand for unplanned care should target socially deprived individuals, but they can be especially difficult to identify in rural areas where overall affluence may mask individual deprivation [32]. This review found that chronic illness management, telemedicine and community health clinics all had potential to reduce use of unplanned health care by rural populations. Future research should evaluate interventions more robustly and more clearly report the results.

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Table 1. Selected studies in review

Evaluation publication	Location & duration	Followup, weeks	Risk factor or Reason for treatment	Intervention descry ption
Armstrong & Haston 1997	Scotland, UK 1+ yr	52	Minor injuries	Telemedicine link between the emergency room of a remote community hospital and emergency department of a large urban hospital.
Benger et al 2004	England, UK; up to 7 days	1-2	Trauma	GP assessment compared to results if emergency medicine (EM) specialist or remote EM specialist (telemedicine) did assessment; patients randomly assigned to just one doctor's advice
Bradley et al 2007	Northern NSW Australia; <= 3-4 yrs	156	Mental illness or substance abuse	An open-ended weekly outpatient group intervention, consisting of motivational interviewing and cognitive behaviour therapy .
Brennan et al 1999	NJ, USA; unclear duration	72 hours	15 minor conditions	Experimental patients were evaluated and treated by a telemedicine nurse in person or rural emergency physician via telemedicine link.
Crane et al 2011	NC, USA; 4yrs 1 month	4-9	Asthma	Preventative education program briefly administered (20 minute session) in emergency room presentations.
Dellasega & Zerbe 2000	PA, USA; 2 weeks	2, 4, 6	Post-hospitalization care	Nurse directed post-discharge care to elders involving two pre-discharge visits by an Advanced Nurse Practitioner and possible additional tel. contacts and visits if needed.
Dracup et al 2014	Rural areas of USA; up to 6 months	104	Heart failure	Control plus 2 intervention groups: both intervention groups had face-to-face education session. Group 1 received two follow-up phone calls, while Group 2 received bi-weekly calls until patient judged to be adequately trained.
Finkelstein et al 2011	Minnesota, USA; 9 months	9	Any, usually chronic	Home telehealth service (web portal) allowed videoconferencing and electronic messaging for frail elderly people living independently.
Gruenewald et al 2013	VA, USA; Ongoing	4, 9, 22	Cancer	Coordinated care-home telehealth (monitoring devices) for outpatient veterans with cancer.
Hoechsmann 2012	Canada; 2 years	104	Anything	A territory-wide picture archiving and communication system was implemented.
Kates et al 1997	Canada; ongoing	52 or NA	Mental illness	psychiatrist provides telephone backup concerning mental health problems to family physicians
Larson et al 2010	Australia; 1 x 20 minutes + GP consult	52	Asthma	A single, nurse led, patient education session to create an action plan tailored to medication needs and symptoms, completed in collaboration with patient, and reviewed by GP in later consultation.
Lewis et al 2013; Sonola et al 2013	UK; multi years	26 52-156	Any, usually chronic	Devon Predictive Model identified patients at high risk of an emergency admission. Professional teams from health, social care and the voluntary sector put patients on a Virtual Ward for pro-active, intensive case management.
Mitton et al 2007	Alberta, Canada; ongoing	26, 52	Chronic	The physician and nurse (and maybe other allied Health Professionals) developed collaboratively, a shared care plan for each patient.
Miyasaka et al 1997	Japan; continuous monitoring	26	Respiratory failure	High definition remotely controlled video cameras in the home to allow staff to remotely monitor ventilator performance & breathing statistics

O'Cathain et al 2007	England, UK; 5 yrs	208	Anything	Population surveys used to explore impacts of new services on demand for traditional providers of unscheduled care.
Ono et al 2013	Japan; 3.5 yrs	182	Suicide	A community-based multimodal intervention for suicide prevention
Postma et al 2011	WA, USA; 8 sessions in 8 months	17-52	Asthma	Home-visitation intervention designed to decrease environmental triggers for pediatric asthma in rural Latino families.
Rasekaba et al 2009	Kyabram, Australia; 3 or 8 weeks	52	COPD	Once-weekly, eight-week multidisciplinary Pulmonary Rehabilitation program as an integral part of the COPD chronic disease management program
Rettig et al 1986	NE, USA; <= 12 visits in 6months	26-52	Diabetes	Health nurses provided individualized instruction in diabetes self-care within the home,
Rust et al 2009	GA, USA; 3 years	156	Any	Community health centers subsidized by grants from US Federal Government under Section 330.
Sabeson & Brennan 2011; Thaker et al 2011	Queens-land, Australia; ongoing	survey over 52-182 weeks	Cancer	Telemedicine model for cancer care (tele-oncology) in northern Queensland, Australia, compared with the usual model of care from the perspective of the Townsville and other participating hospital and health services
Saffle et al 2009	UT, MT, ID, USA; 2+ yrs	over 104 weeks	Burns	Video consultation with acute burns specialists and remote hospitals
Saurman et al 2011	NSW, Australia, continuous	78	Mental illness (any)	Video assessments of mental health conditions
Smith et al 2001	WA, USA; 4 months	2 days	Anything	"Transferring non-urgent 911 calls to a 24-hour consulting nurse line rather than sending a basic life support unit" [ambulance]
Stampehl et al 2012	American midwest, 7-90 days	13	Heart failure	Telehealth technologies and a heart failure nursing outreach program. Phone calls and daily symptoms monitored by Cardiocom telescale for 90 days.
Thiel et al 2013	Wales UK; 1 yr of data	78	Any, usually chronic	Community resource teams delivering integrated care in homes and communities.
Valery et al 2010	Islands of Australia; 6 months.	52	Asthma	67 indigenous peer educators, made minimum three home visits to promote awareness of asthma management in children.
van den Berg et al 2010	Germany; 2 yrs	104	Usually Chronic	Physician assistant rather than General Practitioner sometimes saw patients in own homes.
Varma et al 2010	USA; 12-15 months	13-63	Heart failure	Remote home monitoring of patients with implantable cardiac electronic devices
Westbrook et al 2008	South Australia; 18 months	77	Major trauma, critical care	Before-and-after study of use of ultra-broadband connection allowing real-time audio-visual communication between clinicians at distant sites.

Table 2. Interventions that had statistically significant reductions in unplanned care use.

Population and setting	Study design (n)	Intervention summary	Statistically significant results
Frail elderly people in rural Minnesota, USA	Randomised controlled trial. 44 patients intervention, 40 pt controls	Home telehealth service for frail elderly living in community [58]	Based on weekly interviews (so self-reported) and compared to 40 control subjects, 44 intervention participants made fewer emergency department visits (5 vs. 17, p value for difference = 0.015), had fewer visits in all categories of home care utilization (12 vs. 50; p<= 0.05), and lower use of transportation services (15 vs. 26, p = 0.017).
Children on home ventilators in Japan	10 patients, observed before and after equipment installation	Tele-monitoring of children on home ventilators [69]	In a group of 10 patients over 6 months before and after equipment installation, there were 24 unscheduled hospital visits before, and 5 visits after installation of equipment (p<0.01).
Rural population of in Japan	Rates observed before and after implementation of multimodal intervention (631,133 participants)	Suicide prevention program [60]	Rate of suicides in the intervention group decreased 7% compared with that of the control group. Subgroup analyses demonstrated suicide rate in the intervention group was significantly lower in males (RR = 0.77, 95% CI 0.59–0.998, p = 0.0485) and the number of suicide attempts was significantly lower in males (Rate Ratio = 0.39, 95% CI 0.22–0.68, p = 0.001) and the elderly (RR = 0.35, 95% CI 0.17–0.71, p = 0.004).
Children of migrant agricultural labourers, rural USA	866 patients, before and after receipt of asthma management education	Asthma self-management [52]	Average number of emergency hospital admissions in 12 months before intervention = 0.46 per participant, falling to 0.22 in 12 months after intervention (decline > 50%; p < 0.005).
Small town in rural area of Australia	Concurrent comparisons of 29 patients in intervention programme compared to 24 in opt-out cohort	COPD self-management [47]	Significant reductions in cumulative acute hospital care utilization indicators (95% emergency department presentations, 95% inpatient admissions, 99% length of stay; effect sizes = 0.62-0.66, p < 0.001) 12 months after the introduction of the program; in contrast, changes in the cumulative indicators were statistically insignificant for the non-intervention cohort (emergency department presentations decreased by 5%, inpatient admissions decreased by 12%, length of stay increased by 30%; effect size = 0.14-0.40, P > 0.05).
All population in rural counties of Georgia, USA	Concurrent visit rates from counties with accessible primary clinics (population total = 215,559) compared to visit rates from counties without such clinics (population total = 1,351,919).	Community health centres (CHCs) for primary care in poor communities [38]	Counties without a CHC had 33% higher rates of uninsured all-cause Emergency Department (ED) visits per 10,000 uninsured population. Compared with non-CHC counties (rate ratio=1.33, 95% CI=1.11-1.59). Higher ED visit rates remained significant (RR=1.21, 95% CI=1.02-1.42) after adjustment for percent of population below poverty level, percent black, and number of hospitals. Uninsured ED visit rates were also higher for various categories of diagnoses, but remained statistically significant on multivariate analysis only for ambulatory care sensitive conditions (adjusted RR=1.22, 95% CI=1.01-1.47). No such relationship was found for ED visit rates of insured patients (RR=1.06, 95% CI=0.92-1.22).
Rocky mountains area of USA	Before and after count of emergency air transport events	Acute burns telemedicine assessment and advice [61]	Only 31 patients (of 70 presentations) seen by telemedicine received emergency air transport (44.3% of total, in 25 month period after program was introduced), compared with 100% of 29 patients who presented in the 25 months before the program was implemented (p < 0.05).
Rural Australia	Before and after patterns of use and measures of aspects of care. N=169 patients in 12 months before, and n=181 patients in 18 months after.	Telemedicine to assess and possibly treat suspected major trauma [66]	For critical care patients, admissions fell significantly (54% to 30%; p = 0.01), transfers increased (21% to 39%; p = 0.01), and more procedures were performed. For moderate trauma patients, discharges increased significantly (45% to 63%; p = 0.039), and transfers decreased (48% to 25%; p = 0.01).