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Original Study

Home First! Identification of Hospitalized Patients for Home-Based Models of Care

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ABSTRACT

Keywords:

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Objectives: To determine the proportion of hospitalized inpatients suitable for an acute and subacute home-based inpatient bed substitutive service, to examine the ability of treating teams to identify suitable patients for this service, and to examine potential barriers toward inpatients receiving home-based care.

Design: Prospective point prevalence study over 2 days in April 2019; analysis of responses to survey questionnaires regarding the suitability for home-based care among inpatients with multiday admissions to acute and subacute wards in the Royal Melbourne Hospital (RMH), an Australian metropolitan tertiary referral center.

Setting and Participants: Ward treating teams, clinicians affiliated with the home-based service called RMH@Home, and inpatients who were subsequently identified as being suitable for home-based care.

Measurements: Point prevalence and characteristics of inpatients suitable for a home-based bed substitutive service; identified by either treating teams or RMH@Home clinicians; and barriers to the provision of home-based care among ward inpatients.

Results: Survey responses were received for 620 of 635 inpatients [median age 69 years (interquartile range 53–81), 53% male], of which 69 (11.1%) were identified as being suitable for home-based inpatient bed substitution care. Treating team clinicians identified 26 patients, clinicians affiliated with RMH@Home identified a further 43 suitable patients. The most commonly reported barrier (38.1%) toward receiving home-based care was functional disability impeding ability to live at home.

Conclusions and Implications: A substantial proportion of hospitalized older patients could use home-based inpatient bed substitutive services. Clinicians experienced in home-based care are more skilled than ward-based clinicians in identifying suitable patients for this care model.

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Major metropolitan hospitals experience difficulties around prolonged emergency department waiting times, inpatient bed access, and patient flow due to the increasing numbers of frail and multimorbid patients commensurate with an aging population.^{1–3} Hospital-based care is costly and is associated

with high incidences of complications such as delirium, functional decline, hospital-acquired infections, and medication errors, particularly among frail, older individuals.⁴ Tools such as the “appropriateness evaluation protocol” have been developed to characterize the hospitalization process and assess the necessity of hospital admissions.⁵

Home-based inpatient bed substitutive model of care, previously called “Hospital in the Home” (HITH), and now termed “RMH@Home,” is emerging as an alternative method of delivering cost-effective acute medical and surgical treatments and rehabilitative programs to patients in their own homes. It is associated with lower inpatient mortality and readmission rates, and increased patient and carer satisfaction.^{6–8} There is also

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emerging interest in exploring this model of care for postoperative surgical patients.⁹ However, there remain multiple forms and definitions of this model of care, ranging from complete inpatient bed substitution care to early supported discharge programs and outpatient support services.^{10–14} The range in models of RMH@Home has led to difficulties in developing an evidence base, and consequently difficulties in accurately selecting inpatients who would be suitable for this model of care.

This study aimed to identify the proportion of inpatients potentially suitable for an acute and subacute home-based model of care. Our home-based model of care provides a continuum of home-based acute and subacute care, with patients receiving complete acute medical, surgical, or rehabilitation inpatient bed substitution care in their homes. This study also aimed to describe the barriers that confine patients to ward-based inpatient hospital care.

Methods

Setting and Participants

The point prevalence study included all multiday admitted inpatients of the Royal Melbourne Hospital, Melbourne, Australia (a metropolitan tertiary hospital), except for patients in the intensive care unit, emergency department, day surgery ward, and 40 patients admitted to the home-based care program (RMH@Home). The Royal Melbourne Hospital is a 1400-bed major metropolitan hospital with the full suite of medical, surgical and rehabilitation services, with 105,493 inpatient admissions across acute and subacute services in 2018/19.¹⁵ Acutely unwell patients are admitted into the Acute-X- Campus, and subacute patients requiring rehabilitation care are admitted into the Subacute-X- Campus.

The home-based care program, known as RMH@Home, has 2 teams providing a 45-bed acute service (RMH@Home acute) and 10-bed subacute rehabilitative service (RMH@Home subacute) over a geographical distance of 30 square kilometers in northwest Melbourne, termed our primary catchment area. Our multidisciplinary service maintains medical governance and is capable of providing the full suite of ward-based care via provision of physician doctors, nursing, and allied health visits to the home to replicate the in-hospital service as closely as possible. Patients receive multiple home visits daily by nursing staff and allied health personnel depending on clinical need. Nursing staff, visiting twice daily between the hours of 8 AM and 8 PM, perform in-home phlebotomy and administer intravenous infusions of fluids or medications (ie, antibiotics) under the oversight of physicians. Low-dose oxygen supplementation via nasal cannula can be administered to mildly hypoxic patients via portable oxygen tanks. Physician assessments use a mix of telehealth and in-person reviews, with in-home reviews targeted toward patients who require physical examination or those unable to participate in telehealth because of lack of technology or vision and hearing impairments. The subacute rehabilitative service provides inpatient-level rehabilitation to patients after joint replacement surgeries, acute neurological events (eg, strokes), those physically deconditioned following prolonged hospitalization, and so forth. Physiotherapists, occupational therapists, dietitians, and allied health assistants are a major component of the subacute rehabilitative service. The program also has the ability to partner with regional and rural health services to deliver home-based bed substitutive care for patients living outside the primary catchment area via a combination of home reviews by local health care nurses, medical governance, and in-person or telehealth reviews from the RMH@Home medical team.

The study has been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and was approved by the Melbourne Health ethics board, project number QA2019132.

Survey Procedures

Over April 10 and 11, 2019, health care professionals from each ward of the Royal Melbourne Hospital participated in a structured point prevalence study surveying the suitability of current ward inpatients for the RMH@Home service. Administration of the questionnaire occurred following a 10-minute presentation regarding the RMH@Home service with the aim of ensuring all surveyed health care professionals had a basic understanding of the treatments and care provided by the home-based service. The questionnaire was adapted from the “Appropriateness Evaluation Protocol,”⁷ coupled with additional questions encompassing patients' functional abilities and allied health involvement as a marker of suitability for home-based treatment ([Supplementary Material 1: Survey questionnaire](#)).

A health care professional was nominated by treating teams to complete the structured point prevalence survey; this was usually the clinical nurse on the ward involved in the patient's care. The questionnaire asked treating teams whether their inpatients were suitable for home-based bed substitutive care via RMH@Home, and sought details about the clinical reasons underlying the respondent's choice. Patients who were initially identified as unsuitable by their treating clinicians were subsequently reviewed by RMH@Home clinicians. RMH@Home clinicians confirmed these patients as being suitable or unsuitable for home-based care. Patients identified by either treating teams or RMH@Home clinicians as being suitable for home-based care were next surveyed as to whether they would accept this program should it be offered to them by their treating teams.

Hospital ward patients were excluded from being considered for home-based care if they were clinically unstable (defined as requiring critical care team involvement in the past 24 hours, or having abnormal vital signs limiting the patient's ability to transfer home safely), being perioperative either 24 hours before surgery or 48-hours after surgery, were fasting or on a modified diet unable to be provided at home, or were not functionally suitable from a physical or cognitive state to be cared for in their usual home environment.

Features that identified “potentially suitable” inpatients for a second review by RMH@Home clinicians were those who had vital signs within normal limits, were functionally suitable to return home besides treatment requirements such as supplemental oxygenation or pain management needs, were awaiting an investigation or procedure, or whereby the treating team were unable to state explicit reasons why they were not suitable for RMH@Home.

Assessment of functional ability included domains of mobility, ability to conduct activities of daily living such as personal hygiene care, toileting, eating, and assessment of cognition and risk of deterioration from complications such as delirium. The suitability of patients based on their function depended on their usual pre-morbid function and living situation; for example, residents of supported accommodation facilities with carers on-site would be able to return home with RMH@Home despite being more functionally disabled compared to other individuals who are normally home alone. This “potentially suitable” cohort underwent a second review by RMH@Home team members who reviewed their progress and investigation results regarding suitability for the service.

Patients who were subsequently identified as being suitable to be cared for via RMH@Home were asked whether they would be willing to use the home-based program. This provided additional information about the proportion of inpatients who would consent to home-based care.

Data Collection

Data collected covered patients' demographics, treating team and ward location in the hospital, treating teams' plans for the next 24 hours including dietary plans, assessment of patients' functional

status with regard to ability to perform activities of daily living, signs of clinical stability defined by need for involvement of the critical care team, and vital signs. Treating teams were asked to predict subsequent bed-day utilization as part of formulation of patients' predicted length of stay (LOS) during that admission episode. Patients who were identified as being potentially suitable for home-based bed substitutive care subsequently had additional data collected regarding their date of discharge from hospital, and total hospital-based LOS; and hospital readmission rates in the following 28 days post discharge.

All data were collected by investigators with prior knowledge of the RMH@Home service from medical, nursing, and allied health backgrounds. Study data were collected and managed using REDCap electronic data capture tools hosted by the Hospital Business Intelligence Unit.¹⁶

Statistical Analyses

All characteristics were calculated using descriptive statistics and presented stratified into acute and subacute wards. If normally distributed, data were presented with mean and SD, non-normally distributed data as median and interquartile range (IQR), and dichotomous data as number and percentage (%).

Results

Figure 1 summarizes the outcomes from this point prevalence study, encompassing 635 inpatients admitted to 26 different wards and 48 speciality units in the hospital. Complete responses were obtained from 620 inpatients (488 in acute wards and 132 patients in

subacute wards). Inpatient demographics and characteristics stratified by acute and subacute wards are given in Table 1. The median age of the inpatients was 69 years (IQR 53–81), with 53.4% being male and 57.7% being born in Australia, although 79.1% reported having English as their primary language. Most (75.8%) inpatients lived in the primary catchment area. At the time of the survey, inpatients of the acute wards had been admitted with a median LOS of 5 days (IQR 2–9), whereas inpatients in subacute wards had a median LOS of 13 days (IQR 7–22).

Inpatients Suitable for Home-based Care: RMH@Home

Table 2 describes the characteristics of inpatients identified as being suitable for home-based care. Overall, 69 inpatients (11.1% of all admitted inpatients) were identified in this study, with 26 inpatients identified by their treating clinicians and 43 inpatients identified by RMH@Home clinicians. In the acute wards, 42 inpatients were potentially suitable for home-based care; 12 inpatients were identified by their treating teams and 30 inpatients by RMH@Home clinicians. In the subacute wards, 27 inpatients were identified as being suitable for home-based care by ward treating clinicians (14 inpatients) and by RMH@Home clinicians (13 inpatients).

Of the 69 inpatients, 30 were identified for acute home-based bed substitutive care and 39 were identified to have rehabilitative needs that could be met by the subacute home-based program. Of the 42 acute ward inpatients identified for home-based care, 24 were medical and 18 were surgical patients. Eleven suitable medical patients had multiple chronic comorbidities and an infection such as cellulitis, urosepsis, or pneumonia. Patients with surgical diagnoses were spread across the general (abdominal) and specialty surgical wards. Seven of 18 suitable surgical patients required surgical wound care in association with postoperative management and 3 patients with "colitis" were suitable for home-based care.

Of the 69 inpatients suitable for care via RMH@Home, 35 consented to treatment at home when questioned, 20 were unable to consent due to language barriers or cognitive impairment, and a further 14 inpatients declined care at home. Most (75.4%) identified inpatients lived within the geographical catchment area of RMH@Home, and the remaining 25% could have received home-based care via subcontracted services involving local community health services.

Interrogation of hospital admission data for the 69 inpatients identified as being appropriate for home-based inpatient bed substitution care revealed that the cohort subsequently remained admitted for a median of 3 days (IQR 0–14) in the acute wards, and

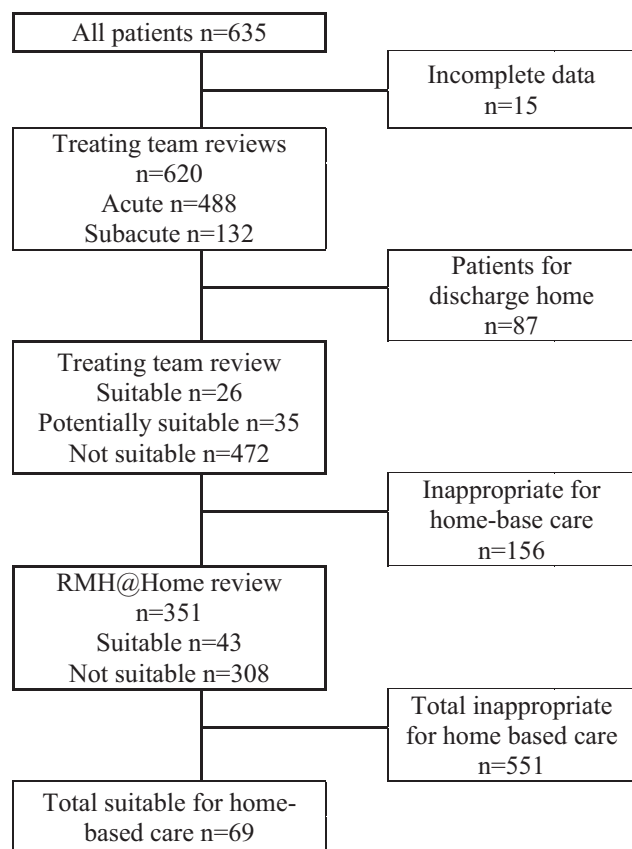


Fig. 1. Summary of the outcome of the point prevalence study of inpatients suitable for home-based care.

Table 1
Characteristics of Inpatients Included in Point Prevalence Study

	Total, n = 620	Acute, n = 488	Subacute, n = 132
Gender, male	331 (53.4)	270 (55.3)	61 (46.2)
Age, y, median (IQR)	69 (53–81)	65 (48–78)	78 (68–84)
Born in Australia	358 (57.7)	290 (59.4)	68 (51.5)
Live in Victoria	599 (96.6)	471 (96.5)	128 (97)
Live within primary catchment area	470 (75.8)	352 (72.1)	118 (89.4)
Marital status			
Married/Defacto	308 (49.7)	251 (51.4)	57 (43.2)
Single/Widowed/Separated/Divorced	290 (46.8)	219 (44.9)	71 (53.8)
Not stated	22 (3.6)	18 (3.7)	4 (3)
English is first language	597 (79.1)	403 (82.6)	94 (71.2)
Interpreter required	98 (16.5)	62 (12.7)	36 (27.3)
LOS on day of survey, d, median (IQR)	6 (2–13)	5 (2–9)	13 (7–22)

All variables are presented as n (%), unless otherwise indicated.

Table 2
Characteristics of Patients Suitable for Home-based Inpatient Care

	Total, n = 69	Acute, n = 42	Subacute, n = 27
Identified by treating team	26 (37.7)	12 (28.6)	14 (51.9)
Identified by RMH@Home	43 (62.3)	30 (71.4)	13 (48.1)
Identified for acute home-based care	30 (43.5)	29 (69)	1 (3.7)
Identified for subacute home-based care	39 (56.5)	13 (31)	26 (96.3)
Lives within primary catchment area	52 (75.4)	30 (71.4)	22 (81.5)
For acute home-based care	23 (33.3)	22 (52.4)	1 (3.7)
For subacute home-based care	29 (42)	8 (19)	21 (77.8)
Patient consents to home-based care			
Yes	35 (50.7)	20 (47.6)	15 (55.6)
No	14 (20.3)	11 (26.2)	3 (11.1)
Unable to consent, that is, unavailable, language barrier, alertness	20 (29)	11 (26.2)	9 (33.3)
LOS characteristics of suitable patients			
Actual inpatient LOS, d, median (IQR)	21 (7–37)	10 (5–28)	34 (23–47)
Predicted LOS, d, median (IQR)	13 (5–23)	7 (4–16)	21 (15–23)
LOS post survey, d, median (IQR)	4 (1–19)	3 (0–14)	6 (4–20)
Total inpatient bed-days following survey, d	675	354	321

All variables are presented as n (%), unless otherwise indicated.

median of 6 days (IQR 4–20) in the subacute wards, equalizing to a total of 675 hospital bed-days (354 bed-days in acute and 321 bed-days in subacute wards). Five of the 69 inpatients were readmitted to the hospital within 30 days.

Identified Barriers to Home-based Care via RMH@Home

Table 3 describes the barriers to home-based care among inpatients, stratified by setting and speciality. The most commonly reported barrier in acute and subacute wards to receiving home-based care was inpatients' inability to live at home due to functional or cognitive impairments (30.9% and 63.5%, respectively). Other reported barriers among inpatients from acute wards were the need to wait for an investigation or procedure (30.6%), being clinically unwell (30.1%), or being in the immediate perioperative period (17.6%). Among inpatients in subacute wards, inappropriate home or social supports were the next most common barrier toward receiving home-based care (45.2%).

Discussion

In a major tertiary Australian hospital, one-tenth of hospitalized inpatients are potentially suitable for home-based inpatient bed substitutive care. Clinicians experienced in providing home-based care were almost 3 times more likely to identify such patients compared with patients' own treating clinicians in acute medical and surgical wards. Major barriers that prevent inpatients from receiving inpatient bed substitutive care at home are physical and cognitive impairments limiting functional independence and a substantial

cohort of inpatients who were awaiting an investigation or procedures.

Large discrepancies between ward clinicians and home-based clinicians in the ability to identify inpatients who would be suitable for home-based inpatient bed substitutive care have been found, particularly among acute ward inpatients. By and large, exposure to home and community-based care is not yet an integral aspect of specialist training pathways, likely contributing to lack of knowledge and experience among ward clinicians with regards home-based models of care.^{17,18} It is also possible that the range of RMH@Home models, ranging from hospital avoidance or inpatient bed substitutive care to outpatient support services for chronic diseases, has contributed to lack of clarity regarding identifying suitable patients for this service, exacerbated by medical specialty training programs which rotate junior doctors across multiple health services; whereby knowledge gained from previous exposure to RMH@Home programs might not hold true for another health service.^{10–14} This finding thus highlights the importance of home-based care services adopting a model of proactively reviewing patients in hospital wards and regularly liaising with ward clinicians in order to identify appropriate patients for home-based treatments. Targeted education and referral pathways for permanent personnel of teams with frequent utilization of home-based care, such as our cardiac failure, internal medicine, or perioperative teams, have also been developed and found to be helpful.

Despite the paucity of published literature regarding patients' preferences for home-based care, we note that out of the potentially appropriate patients for home-based care, half of the inpatients wanted to return home when asked despite receiving no prior educational material about home-based care. This aligns with a

Table 3
Barriers Reported by Treating Teams' Clinicians Limiting Provision of Inpatient Home-based Care by Setting and Speciality

Reported Barrier Limiting Inpatient Home-based Care	Total, n = 473	Acute				Subacute, n = 104	
		Total, n = 369	General Medicine, n = 74	Specialty Medicine, n = 128	General Surgery, n = 30		Specialty Surgery, n = 111
Clinically unstable	124 (26.2)	111 (30.1)	31 (41.9)	38 (29.7)	10 (33.3)	27 (24.3)	13 (12.5)
Perioperative	67 (14.2)	65 (17.6)	1 (1.4)	14 (10.9)	10 (33.3)	36 (32.4)	2 (1.9)
Awaiting investigation/procedure	134 (28.3)	113 (30.6)	26 (35.1)	53 (41.4)	7 (23.3)	12 (10.8)	21 (20.2)
Fasting or modified diet	17 (3.6)	15 (4.1)	1 (1.4)	5 (3.9)	1 (3.3)	8 (7.2)	2 (1.9)
Undergoing new treatment or medication	30 (6.3)	28 (7.6)	5 (6.8)	19 (14.8)	1 (3.3)	2 (1.8)	2 (1.9)
Not functionally or cognitively suitable	180 (38.1)	114 (30.9)	31 (41.9)	34 (26.6)	2 (6.7)	42 (37.8)	66 (63.5)
Inappropriate home, social supports or safety concerns	95 (20.1)	48 (13)	20 (27)	16 (12.5)	0 (0)	10 (9)	47 (45.2)
Other	69 (14.6)	49 (13.3)	6 (8.1)	15 (11.7)	5 (16.7)	21 (18.9)	20 (19.2)

All variables are presented as n (%), unless otherwise indicated. Acute specialities are not inclusive of all acute patients. Barriers are not mutually exclusive.

consistently reported high satisfaction levels of patients admitted into RMH@Home.^{8,19}

The leading barrier why inpatients continue to remain in hospital is due to functional and cognitive impairments limiting their ability to conduct activities of daily living independently. Some models of RMH@Home have addressed this by exclusively focussing on patients in supported living environments and residential aged care facilities.^{20,21} It is possible that future RMH@Home services could be integrated with carer supports to address issues around physical mobility, feeding, and personal hygiene. The need to await diagnostic investigations is another barrier that requires patients to stay in an acute hospital bed, despite having presented to hospital for a median of 5 days prior. This raises the questions around the efficacy of investigations during hospitalization and whether RMH@Home could have a role in provision of diagnostic services while patients are at home.

The advent of telemedicine technologies with the ability to remotely monitor patients' clinical condition and conduct telehealth consultations can aid in addressing the geographical barriers, thus reducing clinical uncertainty and enabling earlier detection of deterioration while patients are at home.^{22,23} RMH@Home services are gradually adapting these telemedicine technologies²⁴ to remotely monitor patients and measure their vital signs as a way to maintain clinical contact and hence emulate some aspects of being admitted to a hospital ward.

To our knowledge, this is the first study investigating the proportion of admitted inpatients who would be suitable for home-based bed substitution care in a major metropolitan hospital with an inpatient cohort representative of the general population. As such, these findings could potentially be generalized to other major metropolitan hospitals. However, this study was conducted over 2 consecutive days and hence might not have representative data regarding patient cohorts admitted over different months of the year.

Conclusions and Implications

A substantial proportion of inpatients in hospital could be treated via a home-based bed substitution program. Clinicians experienced in provision of home-based treatments are more likely to identify suitable patients for the program compared with ward clinicians. Next studies should focus on development and implementation of strategies to better identify patients suitable for home-based inpatient bed substitutive care, and addressing systemic barriers impeding provision of home-based inpatient bed substitutive care.

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Supplementary Material 1. Survey Questionnaire**1. Patient Admission Data**

- a) Patient URN
- b) Bed number, ward
- c) Name
- d) Gender: M/F
- e) Age
- f) Unit
- g) Admission date (to RMH-CC or RPC)
- h) Length of stay – from Admission date to Survey date
- i) Estimated discharge date
- k) Postcode
- l) Predicted Length of stay – from Admission date to Estimated discharge date
- k) Predicted discharge destination

A. Treating team responses

1. Is the patient suitable for ongoing care at home today with RMH@Home?
 - Yes
 - Possibly in the next 24–48 hours
 - No
- a) If yes, with which service?
 - RMH@Home Acute (HITH)
 - RMH@Home Subacute (RITH, GEM@Home)
- b) If no, why not?
 - Clinically unwell/unstable
 - Preoperative
 - Require postoperative monitoring
 - Awaiting further medical input for diagnosis
 - Awaiting diagnostic procedure, ie, blood test, lumbar puncture
 - Require ongoing wound management
 - Require ongoing pain management
 - Require medical imaging – X-ray, CT, MRI, US
 - Undergoing new/experimental treatment requiring direct medical supervision
 - Require infusions, such as IV fluids, IV electrolytes or blood transfusions
 - Drain management (ICC, T-tubes)
 - Not functionally suitable – Hoist, 1A or 2A transfer
 - Not cognitively suitable
 - Do not have a suitable home
 - Lack appropriate social support
 - Staff or patient safety concerns
 - Other
- c) What profession has flagged this as a barrier to discharge?
 - Medical
 - Nursing
 - Allied Health
- d) Does the patient require an interpreter? Yes/No
- e) Does the patient have allied health or subacute team referrals?
 - PT, OT, SW, SP, EP, DT, POD, CLRAAC, No referrals
- f) Would the patient require ongoing allied health care at home today? Yes/No

B. RMH@Home Clinician responses:

1. Is the patient suitable for ongoing care at home today with RMH@Home?
 - Yes
 - Possibly in the next 24–48 hours
 - No
- a) If yes, with which service?
 - RMH@Home Acute (HITH)
 - RMH@Home Subacute (RITH, GEM@Home)
- b) If no, why not?
 - Clinically unwell/unstable
 - Preoperative
 - Require postoperative monitoring
 - Awaiting further medical input for diagnosis
 - Awaiting diagnostic procedure, ie, blood test, lumbar puncture
 - Require ongoing wound management
 - Require ongoing pain management
 - Require medical imaging – X-ray, CT, MRI, US
 - Undergoing new/experimental treatment requiring direct medical supervision
 - Require infusions, such as IV fluids, IV electrolytes or blood transfusions
 - Drain management (ICC, T-tubes)
 - Not functionally suitable – Hoist, 1A or 2A transfer
 - Not cognitively suitable
 - Do not have a suitable home
 - Lack appropriate social Support
 - Staff or patient safety concerns
 - Other

C. Patient responses to verbal question:

- “If your care was able to be delivered at your home, would you be comfortable doing so?”
- Yes
 - No – why?
- Additional information:
 Unable to answer/Impaired cognition/Impaired alertness/
 Interpreter unavailable



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