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ORIGINAL ARTICLE

Dosing practices made mundane: Enacting HIV pre-exposure prophylaxis adherence in domestic routines

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Abstract

Maintaining routines of medication dosing requires effort amidst the variabilities of everyday life. This article offers a sociomaterial analysis of how the oral HIV prevention regimen, pre-exposure prophylaxis (PrEP), is put to use and made to work, including in situations which disrupt or complicate dosing regimes. Other than a daily pill, PrEP can be taken less frequently based on anticipated sexual activity and HIV risk, including 'on-demand' and 'periodic' dosing. Drawing on 40 interviews with PrEP users in Australia in 2022, we explore PrEP and its dosing as features of assemblages in which bodies, routines, desires, material objects and the home environment interact. Dosing emerges as a practice of coordination involving dosette boxes, blister packs, alarms, partners, pets, planning sex, routines and domestic space, and as an effect of experimentations with timing to suit life circumstances and manage side effects. Dosing is materialised in the mundane; a practice that is made to work, as well as domesticated, in its situations. Although there are no 'simple' solutions to adherence, our analysis offers practical insights into how routine, planning and experimentation come

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together to capacitate PrEP to work in people's lives, in sometimes unexpected ways, including through adaptations of PrEP dosing.

KEYWORDS
Australia, dosing, gay and bisexual men, HIV prevention, qualitative, Science and Technology Studies

INTRODUCTION

Whether medicines are taken at the correct intervals, and according to the prescriber's instructions, is an enduring concern in medical practice. Medicalised framings of drug 'adherence' imply that patients ought to comply with medical authorities and position medication use as a matter of acting on individual knowledge and belief (see critiques by Rosenfeld & Weinberg, 2012). Sociologists instead approach adherence as learnt, adapted and practiced in everyday life, mediated by material, spatial and temporal elements (Dew et al., 2014; McCoy, 2009; Nicholls et al., 2021; Race & Wakeford, 2000). This article builds on these approaches by examining how dosing emerges through assemblages in which bodies, routines, desires and material objects interact in the home environment.

The focus of this article is oral HIV pre-exposure prophylaxis (PrEP), an HIV prevention approach which involves HIV-negative people taking antiretroviral drugs to prevent HIV infection (Molina et al., 2022). PrEP has revolutionised HIV prevention in some settings, shifting prevention from encouraging condom use to promoting PrEP use and sustaining adherence (Bernays et al., 2021). PrEP was first made available in the US in 2011, and rollout has been concentrated primarily in high-income countries. In Australia, PrEP first became available in 2014, and the majority of PrEP users are gay and bisexual men (MacGibbon et al., 2022). While initially recommended as a daily pill regimen, multiple PrEP dosing regimens have since been endorsed, which involve taking pills less frequently based on anticipated sexual activity, including 'on-demand' and 'periodic' dosing (ASHM, 2021; Molina et al., 2022; Webster, 2021).

This article examines PrEP users' accounts to explore how varied dosing practices are made to work in relation to their situation and are integrated, adapted and sustained in everyday life. Our approach is underpinned by an 'evidence-making intervention' framework, which involves attending to health interventions as contingent, relational, multiple and made in practice (Rhodes & Lancaster, 2019). Through this framework, we asked 'how is PrEP made to work and put to use?' and considered the sociomaterial and temporal relations situating PrEP (Buse et al., 2018). We argue that dosing adherence is enacted through mundane objects and domestic practices but also the effect of experimentation in response to the variability of life (McCoy, 2009; Race & Wakeford, 2000). In doing so, this analysis offers practical insights into how routine and experimentation come together to capacitate or afford PrEP to work in people's lives, in sometimes unexpected ways.

Assemblages of making PrEP work

In centring a sociomaterial analysis of medicine practices, we conceptualised PrEP not just as antiretroviral pills but as assemblages in which pills, bodies, routines, desires, material objects

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and home environments interact and enfold. By 'assemblages', we mean the emergent, processual and co-constitutive networks of non-human and human actors and practices which shape PrEP and its effects (Duff, 2014; Law, 2004). The concept of assemblage shifts attention from individual agency and experiences to instead focus on the 'array of bodies, technologies, affects and events' (Duff, 2014, p. 35) that work together. Assemblages are not static but instead are 'tentative and hesitant and unfolding' and are 'constructed at least in part as they are entangled together' (Law, 2004, p. 42). Beyond simply implementing a new pharmaceutical product, HIV social scientists have documented numerous socio-technical relations required to create and sustain successful HIV prevention and PrEP uptake, including the coordination of manufacturers, supply chains, state regulation, policies, a supportive health system, community norms, pill taking as a cultural norm and health literacy (Bernays et al., 2021; Holt, 2021; Murphy, 2021). Within this broad array of relations which work to coordinate and stabilise PrEP (Mol, 2002), in this analysis, we focus on the home as a key site of medication practice (Dew et al., 2014).

Paying attention to how PrEP is made to work in the home honed our analytical gaze to the mundane objects, routines and practices through which dosing emerges and is materialised. Medication practices are primarily situated and (re)configured within the privacy of domestic life, involving everyday routines and different relationships with bodies, time and space (Dew et al., 2014; Fox & Ward, 2008; Rosenfeld & Weinberg, 2012). Dosing involves ongoing and processual adaptations to the variabilities of everyday life, including building and sustaining practices and managing disruptions to routines and space (McCoy, 2009; Race & Wakeford, 2000). Mundane household objects also serve to coordinate dosing—for example, the dosette (pill) box is a central mundane object in the coordination of end-of-life care (Morgan et al., 2022). Upon first use, medications themselves can be exotic but often recede into the background of everyday life (Race & Wakeford, 2000). Mundane objects (and technologies) are important to notice precisely because of 'their capacity to be unnoticed, to quietly mediate, that is *reproduce*, what have become the commonalities of everyday life.' (Michael, 2003, p. 128). Through these sociomaterial approaches, we consider how PrEP is situated and domesticated, how it is experimented with and the ongoing effort of making it work.

Situating PrEP dosing in Australia

Oral PrEP can be taken in a range of ways with different intervals between doses, quantities of pills and (for some dosing strategies) the need to anticipate periods of sexual activity and risk in order to achieve effective coverage for HIV prevention. Although initially promoted as a daily pill, PrEP dosing expanded with the addition of 'on-demand' dosing (Molina et al., 2022) and a recognition that PrEP may be taken for limited periods of time. Different ways of taking PrEP have been recognised in Australian clinical guidelines and health promotion materials (see Table 1).

Daily PrEP was the recommended mode of dosing from 2014 until guidelines were updated in 2019 to include on-demand PrEP, which involves taking two pills at least 2 h before sex and then a pill a day for the next 2 days (Murphy, 2021; Philpot et al., 2022; Smith et al., 2021). Daily and on-demand PrEP are considered to be equally effective when patients are adherent (Molina et al., 2022). Periodic PrEP is characterised as daily PrEP for a limited time. It has been promoted as a dosing strategy in Australian health promotion campaigns to encourage PrEP to people who may have shorter periods of sexual activity and HIV risk, for example, when travelling or during a party season (Webster, 2021). Finally, the 'Ts and Ss' dosing method was promoted by some

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TABLE 1 Summary of Australian oral PrEP dosing strategies.

Name/s	Dosing	PrEP guideline recommendation (ASHM, 2021)
Daily PrEP	Take every day	Recommended
On-demand PrEP; event-driven PrEP; 2–1–1 method	Take two pills 2–24 h before sex; one pill per day until 48 h since last risk	Recommended for cisgender men who have sex with men only
Periodic PrEP	Take only during extended periods of risk, for example, holidays, cruises or party events	Not explicitly mentioned in guidelines but functions like daily PrEP
Ts and Ss (Tuesday, Thursday, Saturday and Sunday); intermittent PrEP	Take PrEP every second day or four out of seven doses in a week	Not recommended

peer-based, grassroots PrEP organisations but not approved in official guidelines (for example, www.pan.org.au/how-to). It involves taking pills every second day or four out of 7 days in a week and is based on clinical trial data suggesting that this level of dosing is sufficient to confer protection from HIV (Grant et al., 2014). In 2021, 76% of PrEP users in Australia reported daily PrEP, 20% reported on-demand PrEP and 4% reported periodic PrEP (MacGibbon et al., 2022).

The use of alternatives to daily PrEP has expanded since COVID-19 in which large numbers of daily PrEP users were prompted by lockdown restrictions to consider whether they needed to take pills every day (Hammoud et al., 2021). While official guidelines supported on-demand PrEP prior to 2020, clinicians were apprehensive about recommending it to patients due to concerns about its real-world effectiveness and the capacity of patients to adhere to the 2–1–1 regimen (Smith et al., 2021). Studies suggested that gay and bisexual men were less knowledgeable about on-demand PrEP than daily dosing, and few reported using on-demand dosing prior to 2019 (Chan et al., 2022; Philpot et al., 2022). For example, in 2019, only 5% of PrEP users were using it on demand, which grew to 20% during 2021 (MacGibbon et al., 2022).

Adhering to PrEP

As Nicholls et al. (2021) have argued, adherence is often framed in medicine as patients taking their medications as directed, passively accepting medical expertise and trying to fit medicines into their lives. In this approach, adherence is typically studied as a matter of 'knowledge, belief, and reasoned action' in which barriers are identified and removed to ensure 'correct' adherence. For example, some PrEP adherence studies have indicated low knowledge about how to 'correctly' take non-daily PrEP amongst daily and non-daily users and emphasised the need for improved health promotion and education (Chan et al., 2022; Philpot et al., 2022; Rotsaert et al., 2022). While informative, these studies are focused on 'in/correct' knowledge, sources of information and 'suboptimal adherence', providing less insight into how different dosing strategies are achieved in practice. The emphasis in much of this research has been on how patients can be made to 'adhere' better to dosing regimens as clinically directed, rather than attending to adherence as a situated and embodied practice to be worked at and adapted in light of change and disruption in everyday life (McCoy, 2009; Race & Wakeford, 2000).

Other studies have documented a range of devices and practices involved in PrEP adherence, but most of these studies have focused on daily PrEP (Maxwell et al., 2019; Vaccher et al., 2018).

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In these studies, participants achieved adherence through utilising 'tools' such as phone reminders and dosette boxes; employing visual reminders; and planning contingencies during periods of disruption. These qualitative accounts provide useful insight into the management and practices of adherence, but it is less clear how adherence is enacted in relation to different PrEP dosing strategies, including in the home.

Thus, extending this work, our interest was to examine how PrEP and its dosing is materialised, including in situations which disrupt or complicate dosing regimes, given the rapidly changing landscape and variability of PrEP dosing strategies. In this paper, we attend to how PrEP is made to work through an assemblage of material, spatial and temporal practices and relations (Buse et al., 2018; McCoy, 2009; Nicholls et al., 2021; Race & Wakeford, 2000; Rhodes & Lancaster, 2019).

METHODS

This study was designed with the aim of exploring how HIV prevention is made to work in a situation of evolving guidelines and adaptation to new PrEP dosing strategies. We focused on how PrEP users were enacting these interventions in their everyday life. The study received ethics approval from a human research ethics committee and community-based organisations (see acknowledgements).

We conducted qualitative in-depth interviews with PrEP users in Australia. The team advertised through (1) email invitations to lists of gay and bisexual men who consented to be contacted about future research after participating in previous research studies and (2) through partner organisations sharing social media advertisements and posters in clinical services (see acknowledgements for partner researchers and organisations). Eligible participants lived in Australia, were aged 18 years or older and either used non-daily PrEP or reported pausing, changing or stopping the way they used PrEP in the previous 12 months. Participants were offered compensation of $50 AUD for their time. All participants provided written or verbal consent prior to interviews.

Interviews were conducted by A.S. between January and September 2022 by telephone, videoconferencing or in person, based on participant preference and location. Most participants were interviewed through videoconferencing. Participants were asked about their overall HIV prevention and sexual practices and a range of questions about PrEP, including their personal, social and embodied experiences related to PrEP, their everyday practices storing and using it, their experiences of accessing it from clinics and pharmacies and anticipated future use. Participants were also asked demographic questions, including gender (current and sex recorded at birth), sexuality, age, state of residence, country of birth, ethnicity, and participants chose or asked the interviewer to nominate a pseudonym. On average, interviews lasted 1 h, ranging from 30 to 75 min. Interviews were audio-recorded, professionally transcribed, checked for accuracy, de-identified and organised for analysis with the assistance of NVivo software.

We interviewed 40 participants. Participants (Table 2) were primarily gay cisgender men and were aged between 21 and 77. The majority were born in Australia ($n = 28$), followed by Southeast, Northeast or Southern Asia ($n = 5$), South America ($n = 2$) and one each from Western Europe, England, South Africa, Aotearoa New Zealand and the United States. Australian-born participants, almost all, reported Anglo or European ethnicities, with two participants reporting Asian ethnicities. One participant identified as Aboriginal Australian. Most participants lived in Victoria ($n = 17$) or New South Wales ($n = 14$), Australia's most populous states, with a smaller

TABLE 2 Participant characteristics.

Pseudonym	Sexuality and gender[a]	Age	PrEP dosing
Aaron	Pansexual man	Late 20s	Nil; has dropped off' daily PrEP
Alex	Gay man	Late 20s	On-demand (2-1–1)
Anton	Gay man	30s	Takes regular breaks from daily and takes it on-demand (2–1–1)
Ben	Gay man	50s	On-demand (2–1–1); initially used it as 1–1–1
Brian	Gay man	50s	On-demand (2–1–1); but if sex was 'unplanned', takes pills afterwards over 4 days (sex-2–2–1–1)
Callie	Queer	30s	Nil; stopped daily PrEP during lockdowns
Ciaran	Gay man	50s	On-demand but prefers to start a dose a day early (1–2-sex-1–1)
Craig	Gay man	30s	Daily; contemplating other methods
Dakota	Pansexual non-binary	Late 20s	Daily; switched from on-demand (2–1–1) as they can now afford it
David	Gay man	40s	Takes PrEP every second day, and then daily when he has sex
Don	Gay man	70s	Daily; had paused during lockdowns
Dustin	Gay man	40s	Nil; stopped daily PrEP due to monogamous relationship
George	Homoflexible man	Late 20s	Takes PrEP daily; switches to on-demand (2–1–1) when busy with life
Gideon	Gay man	Late 20s	On-demand (2–1–1); but also takes it daily during gay festivals/events
Hank	Gay man	30s	Nil; stopped daily PrEP and contemplating what he wants from sex
Jack	Gay man	60s	On-demand (2–1–1)
Jason	Gay man	30s	On-demand (2–1–1)
Jay	Gay man	50s	On-demand (2–1–1)
John	Bisexual man/gender non-conforming	Early 20s	Daily; had paused during lockdowns
Kevin	Gay man	30s	On-demand (2–1–...); length of cycle aligns with travel to the city
Kyle	Gay man	40s	Daily; had paused during lockdowns
Liam	Gay genderfluid	Early 20s	Daily; had paused when running out of pills during quiet sexual period
Lucas	Gay man	30s	Takes PrEP every second day to maintain 'tolerance'
Mark	Gay man	30s	Nil; stopped daily PrEP as he does not like how PrEP makes him feel
Michael	Gay man	40s	Shifts between on-demand (2–1–1), every other day, and takes regular breaks to reduce bone damage
Mike	Gay man	Early 20s	Nil; stopped daily PrEP due to monogamous relationship
Myles	Gay man	30s	Daily; had paused during lockdowns and periods of illness

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TABLE 2 (Continued)

Pseudonym	Sexuality and gender[a]	Age	PrEP dosing
Oliver	Gay man	60s	On-demand (2–1–1) if unplanned, otherwise takes it daily for a week before and after planned sex
Paul	Gay/queer man	Early 20s	On-demand (2…) but not yet had sex and needed follow-up doses
Patrick	Gay man	30s	Daily; shift work means that there are sometimes 36 h gaps in doses
RJ	Asexual non-binary	40s	Nil; recently stopped daily PrEP, will take on-demand (2–1–1) if needed
Ryan	Queer; 'other' gender	Late 20s	On-demand (2–1–1); takes PrEP when using drugs and going to sauna
Sam	Gay man	40s	Daily; sometimes runs out of pills due to money
Seb	Gay/queer man	30s	Periodic; takes daily PrEP for specific events, commencing 5 days before
Steve	Gay man	40s	Daily; sometimes runs out of pills due to difficulties accessing pharmacies
Stuart	Gay man	50s	On-demand (2–1-sex-1–1); likes to start the '2' a day early before sex
Tristian	Bisexual man	Late 20s	On-demand (2–1–1); finds timing to 24 h between doses confusing
William	Bisexual/queer man	70s	On-demand (2–1–1)
Xavier	Gay man	Late 20s	On-demand (2–1–1)
Zach	Gay man	40s	On-demand (2–1–1); recently forgot 1 day of follow-up dose

[a]All participants were assigned male at birth.

number living in South Australia (n = 4), Queensland (n = 3) and Western Australia (n = 2). Table 2 also contains summaries of participants' PrEP dosing strategies (described in this table according to participants' own accounts, without necessarily seeking to firmly categorise or delimit these descriptions). Broadly, these variable strategies included on-demand PrEP (n = 18), daily pills (n = 10) and a blend of strategies or periodic PrEP (n = 5). Seven participants had stopped PrEP.

Following each interview, A.S. wrote fieldnotes summarising key topics discussed in the interview and emerging analytical ideas. Fieldnotes informed regular team meetings and guided the direction of subsequent interviews and the conceptualisation of data. For example, the richness of participants' accounts of different pill taking practices and routines led the team to explore these practices further in subsequent interviews and to review theoretical thinking on mundane objects (Buse et al., 2018; Michael, 2003; Morgan et al., 2022) and the materiality of pharmaceuticals in the home (Dew et al., 2014; Rosenfeld & Weinberg, 2012). As data generation finished, A.S. (re)listened to interviews and read the transcripts multiple times, with the aim of identifying extracts related to routines, planning and the materiality and embodiment of PrEP. Through a combination of iterative data analysis and reading, we developed the framing of this paper by asking 'how is PrEP put to use and made to work?' and focused on how different dosing regimens, routines, practices and objects were assembled in the home. Interviews and writing involve fixing objects and processes in time, which risks losing the ephemeral and

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quotidian nature of sociomaterial processes. These accounts therefore provide partial insight into the work of enacting and sustaining PrEP.

FINDINGS

Our analysis identified a range of objects, practices and routines through which dosing emerged as a practice of coordination (Mol, 2002). Making PrEP work involved routines, planning and experimentation. By attending to participants' accounts, we traced how the mundane and variable routines of everyday life, as well as anticipating sex and planning for future contingencies, and the relational, material and spatial arrangements in the home, came together to capacitate or afford PrEP to work in people's lives, in sometimes unexpected ways. Different modes of dosing (be they described as daily, periodic on-demand or otherwise; see Table 2) related differently to routinisation, planning and experimentation, with efforts to sustain and adapt dosing always situated in emergent assemblages that are subject to potential temporal disruption. As a practice of coordination, we found that PrEP dosing is materialised in the mundane: For example, PrEP can involve learning to take a pill every day, setting phone alarms, organising pills into a dosette box, leaving bottles next to sinks or coffee machines, being reminded to take pills by a partner, pet or domestic habit or starting to take pills in anticipation of an upcoming weekend or hookup. Our analysis here focuses on these material practices within their different assemblages (Duff, 2014; Law, 2004) in which different elements emerge together to enact and sustain (or disrupt) dosing, and in turn, HIV prevention.

Routines

Broadly, routines are domestic, material and temporal—they involve approximate and embodied repetitions within the sequencing of daily events and rituals, and they can be punctuated by objects and space which serve as prompts and reminders (McCoy, 2009; Race & Wakeford, 2000). Waking up, showers, morning coffees, leaving the house, mealtimes and getting ready for bed were all key sites for taking PrEP. While many routines 'worked' most of the time, they relied on situated conditions that could be prone to disruption. Kyle (daily PrEP) reflected:

> My routine is normally: get up, feed the cat that's meowing, and then I take my PrEP. That's what I still do now. It's just that if the cat was not, for some peculiar reason, awake and fed, and I didn't feed the cat, then I'd forget to take my PrEP. Or like, if we went out—that once a year when we go out past midnight and then you sleep in—I break that routine and forget to take it.
>
> (Kyle)

The combination of his cat, partner and himself in the usual domestic temporal and spatial patterns of everyday living prompted sufficiently regular dosing for Kyle. While this assemblage was characterised as rather accidental, others purposefully structured life to use PrEP. RJ (stopped daily PrEP) preferred that sexual partners did not sleep over at their home, as the presence of somebody else resulted in a disrupted morning and RJ missing PrEP dosing: 'I was terrified. I'm like, "This cannot happen again," to the point that I remember kicking out people before I get to sleep, so I can wake up at seven to take my pill. I don't do overnights'. Sustaining dosing (when using PrEP) for participants like RJ involved explicitly (re)ordering everyday routines.

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Pill bottles, dosette boxes, and blister packs constituted important mundane objects in routines, functioning as visual reminders and prompting memory. For Kyle, travelling disrupted his routines (away from his domestic space, with his cat and husband), and a blister pack helped him to organise dosing across time zones: 'Without the blister pack, if you lose a day in travelling or you go to sleep three times on the plane, you're like, "I have no idea what day it is or whether I've taken it"'. Dosette boxes and blister packs were useful for organising pills and avoiding accidently double dosing or missing a dose. As David (intermittent/daily PrEP) reflected, 'I can take a tablet and 10 min later I don't remember if I took it or not'. And when commencing a cycle of PrEP, William (on-demand PrEP) took his initial two pills and then labelled the cavities on the blister pack with a permanent marker indicating the remaining 2 days he needed to take it.

The spatiality of homes and relationship dynamics also shaped routines. Storage of PrEP (either in bottles, boxes or packs) in specific locations prompted dosing amidst daily routines: including on bathroom sinks, bedside tables or next to the microwave in the kitchen. To recall taking both his PrEP and ADHD medication before leaving for work, Mark (stopped daily PrEP) relied on multiple post-it note reminders and a backup solution: 'There are two reminders on the front door, one reminder in the kitchen, and spare drugs in my bag in case I do walk out the door without taking them'. Participants and their partners often prompted each other to take PrEP. After long night shifts, Patrick's (daily PrEP) partner would often bring him a meal in bed with his PrEP pills. While some domestic relationships prompted PrEP, a few participants concealed dosing from family or partners. Zach (on-demand PrEP) hid his pills in a travel bag stored in a spare room and anticipated his boyfriend's routines so that he could discreetly dose if he is secretly hooking up with other men.

Routines were adapted to changing life circumstances or dosing strategies. When Kevin (on-demand PrEP) and his partner were using daily PrEP, they checked each other's dosette boxes to prompt missed doses. However, Kevin had switched to on-demand PrEP after deciding he did not need to always be taking it; because he lived in a rural area he only had sex with other partners during weekend visits to the city. At the time of the interview he had only used PrEP on-demand on two occasions and reflected that he had not yet established an effective routine: 'I haven't really found a flow yet. I will, but I don't know what it is yet'. Amongst some younger participants, PrEP was the first regular medication they took, and the effort of 'establishing' a routine was more pronounced than others who fit PrEP into existing dosing schedules.

In this section, dosing emerges as more than human agency and involves an assemblage of objects, space and bodies which capacitate and materialise routines. These accounts demonstrate the contingencies of dosing in which the absence of one element of the assemblage can disrupt adherence (Law, 2004; Race & Wakeford, 2000). However, most of the time routines are vernacular and habitual and recede into the background of everyday life. While routines were often central to daily PrEP, as suggested by Kevin's account, non-daily PrEP often required considerable planning that was less amenable to routinisation.

Planning

Setting up new routines and remembering to take PrEP required effort and planning, but the work of planning dosing differed particularly in relation to varying PrEP dosing strategies. With daily PrEP, dosing could be enfolded into a routine that required less planning effort on a day-to-day basis, assuming that a 'natural' dosing rhythm could be established through locating dosing practices with material objects and domestic routines. In contrast, non-daily and periodic forms of using PrEP required active planning in relation to the anticipation of sex.

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Ciaran (on-demand PrEP) and his husband always planned dosing, as their life in the suburbs with their dogs meant that casual sex with other partners was never spontaneous and always anticipated. Ciaran utilised an adapted version of on-demand PrEP, preferring it to 'build up in your system, [...] like stretching it out a little' at least 2 days prior to sex for what he 'intuitively' sensed to be greater drug effectiveness. In planning sex with a third partner, Ciaran and his husband moved pills from the bathroom to the espresso machine and prompted each other to take PrEP with morning coffees. Beyond organising dosing, this ritual also generated excitement:

> It's like "hey, we've decided we are going to have this guy over and we are going to do this, yay, let's take PrEP". It's like an advent calendar [laughter]—that's such an inappropriate analogy—but it's like "this is day 1, this is day 2, let's fuck" and a couple of days after, you keep going [with PrEP]. So, to me it's actually part of the build up of "we get to do *that* this weekend".
>
> (Ciaran and his husband)

While Ciaran's PrEP as 'advent calendar' afforded excitement, the work of materially and temporally planning on-demand PrEP was more often framed by others as disruptive to spontaneity in sex. Dakota (daily PrEP) had recently switched back to daily dosing as their financial circumstances had improved, having previously been taking on-demand PrEP due to its lower cost (less pills). Dakota disliked the planning involved with on-demand PrEP: 'I just don't really want to have to think about that, I've got too much other stuff going on'. When sex was more spontaneous, participants employed practices to stretch or delay time before sex, as there is a 2-h minimum lead in after the initial dose before PrEP is expected to be effective (Molina et al., 2022). Several participants, including Dakota, discussed strategies to stretch space and time, including pretending to be 'late' to meet a casual hook-up, watching a movie before sex and delaying anal sex by doing 'hand stuff'. In contrast, the timing of dosing daily pills was not framed by participants as disruptive to sex.

The effort of planning also extended to predicting whether PrEP was necessary for specific weekends or outings. Jay (on-demand PrEP) found the 'guess work' of when to commence on-demand dosing frustrating because sex was sometimes unpredictable, but he otherwise liked the peace of mind of taking PrEP and preferred not to be 'unnecessarily' taking pills every day when sex was infrequent. Predicting when sex might occur and whether it would include sexual practices that are a potential HIV risk (e.g., condomless anal sex) also shaped dosing for other on-demand participants. Jason (on-demand PrEP) experienced intrusive thoughts around whether HIV was being effectively prevented by on-demand dosing. Jason initially used daily PrEP and enjoyed how it had removed his longstanding experience of stress with condoms 'having to work' during sex in which he would check if a condom had split or broken after sex. Shifting to on-demand PrEP returned this intrusive sense of an intervention *needing* to prevent HIV:

> For the next 24, 48 hours, it's kind of there stuck in my mind: "You must take this pill! You must take this pill!" And in a way, it kind of goes back to how condoms used to be intrusive. It's sort of re-established a bit of that idea of HIV prevention being intrusive instead of very much a passive thing that is going on in the background.
>
> (Jason)

Jason also found that if a hook-up was unsatisfactory, the follow-up doses haunted him and constituted a waste of pills: 'I kind of think, I just wish I hadn't bothered. [...] I've used these PrEP pills for a hook-up that just didn't feel worth it'. Waste for Jason operated on multiple

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levels, including the unnecessary use of drugs in his body, the cost of pills and the wasted sexual encounter. Other participants described waste similarly. Despite intrusiveness, Jason still preferred to take on-demand to reduce an overall 'wastage' of pills, but it nonetheless required greater effort to plan. The effort of planning highlights how the elements of the assemblage are more actively brought together to enact PrEP, through the coordination of dosing before, during and after the event of sex. This involves routinisation and domestic practices but with different rhythms and effects to daily PrEP. The work of routinising and planning continues into the next section, where we attend to how dosing becomes a practice of experimentation in response to bodily effects.

Experimentation

When asked how PrEP felt in their body, many participants characterised PrEP as feeling like 'nothing' and attributed no 'side effects' or other bodily experiences to PrEP. However, some participants reported a range of unpleasant embodied effects which were either tolerated or required significant experimentation and ongoing work to routinise, plan and manage. We often found the reported severity of these effects surprising, as the field has typically characterised oral PrEP as having few and tolerable side effects (Glidden et al., 2016). Managing these effects required great effort; not unlike the assemblages in previous sections but with much greater emphasis on how dosing related to the embodiment of pharmaceuticals (McCoy, 2009; Persson, 2004). Jason experienced a range of troubling effects, which accounted for part of why he took PrEP on-demand:

> If I start taking it, I feel sluggish. My stomach feels a bit crap. And if I take it before I sleep, I get such vivid dreams, like incredibly vivid dreams that I hate. I don't know if that's caused by PrEP but it feels to me like it's caused by the PrEP 'cause it only seems to happen if I take a pill right before bed. I guess as well that's part of the reason why I'm not taking it daily, because I kind of feel I don't really want to take it unless I have to, because it mostly just leaves my digestive system feeling ravaged.
> (Jason)

These effects seemed to persist whenever Jason took PrEP, leading him to estimate the likelihood of having sex against the possible inconvenience of feeling sluggish. Loose bowel movements, nausea and an upset stomach were the most common reported effects by participants. For some, these effects were only experienced when initiating PrEP, sometimes characterised in the field as PrEP 'start-up syndrome' (Glidden et al., 2016). For others, 'side effects' occurred whenever PrEP was taken, requiring experimentation with routines and mundane objects to minimise these effects as part of the dosing assemblage.

The timing of pill taking (as with Jason's vivid dreams) and whether pills were taken with food were often experimented with to manage effects. For example, Xavier (on-demand PrEP) found that if he took the 2-pill loading dose without food, he experienced stomach cramps within half an hour. For Zach (on-demand PrEP), trying to conceal taking from his boyfriend while also taking them with food to minimise nausea was particularly challenging. Getting the timing of PrEP dosing 'right' therefore emerged not only as a matter of achieving effectiveness (e.g., the goal being at least 2 h before sex with on-demand PrEP) but also as a matter of how easily (or disruptively) the 'right' timing came together with other domestic routines and priorities, such as sleeping, eating, avoiding nausea or discreetly taking pills.

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The embodied effects of PrEP temporally structured how some people took pills in novel ways. When Lucas (intermittent/daily PrEP) commenced PrEP, he found food nauseating. This lasted over a month, and although it subsided, Lucas continued to find the smell and sight of some foods nauseating and therefore inedible. At the time of the interview, Lucas was taking a break from sex and decided to take PrEP every second day to maintain some drug level in his body, as he was afraid of restarting PrEP and experiencing nausea again. Upon anticipating casual sex, he planned to return to daily dosing.

Others timed dosing in different ways to overcome symptoms. Stuart (on-demand PrEP) found that nausea subsidised a day after his initial two pills, and so he preferred to commence his dosing cycle a day earlier than when he anticipated having sex to overcome the nausea. Stuart had experimented with taking PrEP with food but found that he just needed to persevere through the nausea and commence a day early:

> I started by taking PrEP with my lunch, but I found it nauseated me, well certainly the double [pills] nauseated me. And there were times when I was still feeling nauseous when we're catching up for play. [...] so I figured OK I just start a day early, so that's my 2-1-1-1.
>
> (Stuart)

Dosing with side effects was often complicated. Seb (periodic PrEP) was lactose intolerant and attributed a range of effects (upset stomach, sore joints and excess phlegm) to the lactose contained in PrEP pills, which he found comparable to taking other medications or consuming food or beverages containing lactose. Although he searched for different generic brands of PrEP to try, he could not find a subsidised product without lactose and so experimented with the timing of side effects in anticipation of sex:

> I don't really have a strict formula but it's usually four or five days [of taking PrEP] just mainly so that if I do get a bit of an upset stomach, at least that bit of it resolves. The phlegm at the back of my throat actually gets worse over time but the stomach thing kind of settles. [...] so I start taking it on the Monday, if I haven't had any sex on the Saturday, which is what happened last time, I just stop taking it immediately. But if I had sex, then I would have taken it for probably a couple of days or more after.
>
> (Seb)

While dosing routines were adjusted in relation to anticipating predictable bodily effects, Michael's (nondaily PrEP) anticipations of what PrEP would do to his body were less certain. Michael was taking daily PrEP when diagnosed with osteoporosis by a doctor, which he was told was unlikely to have been caused by PrEP but could be worsened by it. The diagnosing doctor recommended he completely stop PrEP, but Michael was not willing to give up condomless sex—something he had never experienced until using PrEP and profoundly enjoyed. Instead, with support from another doctor, Michael experimented with taking PrEP every second day, taking concentrated breaks from pills (and sex) and using on-demand PrEP. He reflected on his approach:

> My main priority is to prevent bone breakages 'cause that's my biggest fear at the moment, given the severity of the osteoporosis and not being sure to what extent PrEP is contributing to that. There's so much conflicting science around it. [...] [Until osteoporosis] I had no intention of even pausing or stopping, or changing the way

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> I was taking PrEP. It's really the health issues that are changing the way I'm taking it now.
>
> (Michael)

Unlike other participants who could alter elements of their dosing assemblage in response to obvious bodily effects, the effects of PrEP on Michael's body were unknown between two-yearly bone scans. This left him enacting a modified dosing regimen coordinated to periods of sexual activity without knowing if this was effective in protecting bone density.

DISCUSSION

In this study of PrEP dosing practices, we found that PrEP dosing was entangled within assemblages of mundane objects, partners, pets, pills, bodies and the home environment. Evolving and variable situations demanded not only routine and planning but also experimentation, with dosing emerging as a practice of coordination in which things come together to capacitate PrEP to work (or not work so well). Many of the aspects of medication use, we analysed are mundane and less attended to in medical discourse (Buse et al., 2018; Michael, 2003; Morgan et al., 2022). However, it is the quotidian aspects of these socially, materially and temporally mediated practices that provides insight into how interventions are made to work in practice, sometimes in unexpected ways (Rhodes & Lancaster, 2019).

Adherence as distributed agency

Although adherence is often constituted in medicine as a matter of reasoned action, privileging an individual rational actor responding to medical instructions, we argue that dosing involves *distributed agency* in which the practice of dosing is coordinated through entangled human and non-human actors, as well as spatial and temporal arrangements. Some of the elements of making dosing are quotidian or serendipitous, while others involve deliberate attention and care or a specific set of conditions or situations, for ensuring that dosing occurs on time and on schedule (McCoy, 2009; Race & Wakeford, 2000). PrEP users enroled partners and pets, objects (dosette boxes, blister packs, bottles and phone alarms), space (kitchen counters, bedside tables and bathroom sinks) and routines (sleeping, hygiene practices and mealtimes) with varying degrees of responsibility for enacting PrEP. As a matter of producing an 'iterative practice among mobile actors in a changeable world' (Race & Wakeford, 2000, p. 217), dosing involves ongoing care and effort. Importantly, these elements and conditions of a dosing assemblage may be gradually adapted, experimented with, forgotten, disrupted or sustained over time and through everyday life. In participants' accounts, the contingencies and ongoing labour involved in making PrEP work were revealed by disruption to everyday routines, the effort of anticipating when non-daily dosing was necessitated by anticipated sex and the experimenting dosing in relation to unwanted effects of PrEP.

PrEP and dosing as multiple

PrEP is an interesting case study for conceptualising the materiality of dosing practices, not only because of the effort involved in anticipating sexual futures and HIV risk (Race, 2016) but

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also because of the different possible ways of taking PrEP (Molina et al., 2022). While the field presents tidy categories of PrEP dosing strategies—for example, daily, on-demand, periodic—our interview accounts trouble the boundaries of these strategies. Some participants may have gotten these strategies 'wrong' at times (e.g., taking more or fewer pills than clinically advised), which may mean there are opportunities to improve education about effective dosing (Chan et al., 2022; Philpot et al., 2022; Rotsaert et al., 2022). However, rather than characterising these instances as failures or problems, we see them as a normal part of the messiness of translating health interventions into everyday life, as these always involve localised and embodied experimentations (Rhodes & Lancaster, 2019). Participants put an enormous effort into adjusting dosing to undesirable 'side effects', to suit preferences for doing HIV prevention or to fit the timing of PrEP into the variously predictable and unpredictable elements of life (Vaccher et al., 2018). These experimentations resulted in the enactment of multiple PrEPs (Rosengarten & Michael, 2009). This study challenges the stability of the different PrEP dosing strategies offered in the sector, with distinctions between the strategies often being blurrier in practice.

Qualitative studies of PrEP adherence have documented a similar range of objects and practices that we found supported adherence in our study, although these earlier studies primarily involved daily PrEP users (Maxwell et al., 2019; Vaccher et al., 2018). Our study provides insight into how nondaily PrEP adherence is materialised. For some, 'establishing' a routine was more challenging as dosing was infrequent and spontaneous, but for others, non-daily dosing was not felt to be especially difficult or inconvenient, although it might require specific effort (delaying tactics, setting up a reminder) or spatial and temporal arrangements that were novel in comparison to what was made possible (or what had been done with perhaps more ease) in the mundane routine of daily dosing. On-demand PrEP also produced different affects for some, including anxiety about prevention effectiveness, demonstrated through 'extra dosing' and a sense of PrEP 'needing to work' or varying degrees of sexual excitability and frustration in relation to dosing in anticipation of or after sex. Assemblages are affective (Duff, 2014) and in the case of PrEP dosing involve relational aspects of sex, pleasure and anticipating HIV risk (Race, 2016).

Dosing and Pharmakon

Although side effects of PrEP are recognised as a problem in the field—including as reasons for stopping PrEP (MacGibbon et al., 2022; Maxwell et al., 2019)—an unexpected aspect of our study was the extent to which these embodied effects of PrEP were challenging for some participants and thus how bodies, time and space came together in these situations to disrupt PrEP and its dosing. These participants usually persisted with PrEP, developing intricate ways of minimising these effects, with dosing practices being challenged by but also being worked into other everyday domestic practices like eating and sleep. These aspects are worth revisiting considering what clinical trial data have suggested about PrEP. While documenting some 'side effects' in the context of daily PrEP, particularly in relation to the 'start-up syndrome', Glidden et al. (2016) wrote that 'the vast majority of those who do experience a "start-up syndrome" successfully "overcome" it within the first few months of PrEP use' (p. 1176). Although true for many participants, we also spoke to participants who experienced a significant range of effects, often requiring them to alter dosing practices or to simply persist through feeling unwell. Vaccher et al. (2018) similarly reported that some participants altered routines to minimise side effects, and our study adds further insight into how bodies, time and space are altered to enact different effects with PrEP.

The concept of *Pharmakon* in which medicines are understood to possess both curative and poisonous potential is important here (Persson, 2004). While medical discourse most often

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emphasises the curative aspects of pharmaceuticals and has the luxury of constructing what constitutes a 'side' effect and whether these are significant and made real and knowable (often in the confines of clinical trials), people are often left to evaluate and manage the effects of drugs in practice (Persson, 2004). Drug effects are also not universal and are constituted in their local and relational ecologies (Rhodes & Lancaster, 2019). The presence and absence of embodied effects in relation to medication use form an important part of the work of dosing, especially as dosing for some people and some medicines may involve significant effects, while for others it is dissociated from immediate bodily experiences (McCoy, 2009). As we show in our analysis, the bodily effects of PrEP were a key part of the broader assemblage involved in dosing.

Sustaining dosing and HIV prevention

While some participants found specific strategies or technologies useful for dosing on time, these all required active work to integrate into everyday life and to sustain (McCoy, 2009). The different practices in our participants' accounts could be adapted into health promotion or clinical advice. However, we want to stress that there are no 'simple' solutions to the work of adherence, precisely because adherence is a matter of doing things on time in a world of constant (but often subtle) variability. This ongoing work of adherence is reflected in Race and Wakeford's (2000, p. 223) argument that dosing practices must be 'kept alive'. As they point out, there is a danger in habits becoming too 'automatic' and 'unmemorable' because their absence may be unnoticed. The maintenance of a range of objects and routines therefore must be continuously negotiated in subtle and largely domestic and mundane ways (Buse et al., 2018; Morgan et al., 2022; Rosenfeld & Weinberg, 2012).

The population level, 'successful' rollout of PrEP in Australia may give the impression that taking PrEP is easy, desirable, reasonable and sustainable—and it may well be for many people who continue to use it (Kirby Institute, 2022). At the same time, the international field is looking towards 'long-acting' forms of PrEP, including injectable and implantable pharmaceutical agents that last several months at a time (Philbin & Perez-Brumer, 2022). It may be tempting to consider that these new clinical interventions may provide a solution to the everyday mess of taking pills, partly because these agents are likely to be administered in the clinic rather than in the household. However, rather than necessarily removing challenges, we argue that new PrEP modalities will produce different forms of work that require attending to, including by transforming and extending material, social and temporal care arrangements. For example, these transformations have been observed with monthly opioid treatments, producing new and unexpected temporal arrangements in people's everyday lives and health care (Lancaster et al., 2022).

CONCLUSION

Although adherence is often problematised in medicine as a matter of improving knowledge, belief and reasoned action (Nicholls et al., 2021; Rosenfeld & Weinberg, 2012), taking a socio-material approach to people's situated narratives can reveal adherence as materialised in assemblages in which bodies, routines, desires, material objects and the home environment capacitate dosing (Buse et al., 2018; McCoy, 2009; Michael, 2003; Race & Wakeford, 2000). Beyond a biomedical promise, our study gives insight into how interventions are made to work in everyday life (Rhodes & Lancaster, 2019). In turn, these quotidian dosing practices structure the intervention in novel ways that are vital to understanding its distributed and multiple effects. In the case of

PrEP, we found that the domestic space—including the intertwined routines, relationships and mundane objects—was a key site in which this HIV prevention strategy was enacted. Our analysis shows that dosing practices are experimented with to work amidst people's changing lives and to persist through side effects, and dosing practices trouble the field's categorisation of PrEP strategies. Considering the mundane and domestic practices of dosing generates insight into how adherence is materialised and how conditions for capacitating dosing might be better supported.

AUTHOR CONTRIBUTIONS

Anthony K. J. Smith: Conceptualization (Equal); Data curation (Lead); Formal analysis (Equal); Investigation (Lead); Methodology (Equal); Project administration (Lead); Writing – original draft (Lead). **Kari Lancaster**: Conceptualization (Equal); Formal analysis (Equal); Funding acquisition (Equal); Methodology (Equal); Supervision (Equal); Validation (Equal); Writing – review & editing (Equal). **Tim Rhodes**: Conceptualization (Equal); Formal analysis (Equal); Funding acquisition (Equal); Methodology (Equal); Supervision (Equal); Validation (Equal); Writing – review & editing (Equal). **Martin Holt**: Conceptualization (Equal); Formal analysis (Equal); Funding acquisition (Equal); Methodology (Equal); Supervision (Equal); Validation (Equal); Writing – review & editing (Equal).

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The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Research data are not shared.

ETHICS STATEMENT

Ethical approval was provided by the UNSW Human Research Ethics Committee (HC210245), the ACON Research Ethics Review Committee (ACON RERC 202116) and the Thorne Harbour Health Community Research Endorsement Panel (THH/CREP 21-017).

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