



Research article

Contact Tracing and Isolation Adherence in Community Outpatient Clinics During COVID-19: Effectiveness and Implementation Barriers

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Article history

Received: January 23, 2019

Accepted: February 03, 2019

Keywords

COVID-19; contact tracing; isolation; quarantine; adherence; primary health care; outpatient clinics; community health workers; implementation science; sub-Saharan Africa

DOI:

10.53517/JCKHH.25

81-3331.62202278

ABSTRACT

Contact tracing and isolation were among the most widely used public health responses to COVID-19, and community outpatient clinics often sat at the centre of these efforts because they were where symptomatic people first sought care, were tested and received advice on staying at home. Despite heavy investment in tracing programmes across high-, middle- and low-income countries, the contribution of these measures to epidemic control was uneven, and the part played by clinics in that outcome has received relatively little attention. This review examines how effective contact tracing and isolation were, how well they worked when delivered at scale, and why their performance so often fell short, with a particular focus on community clinics and on settings in sub-Saharan Africa such as Nigeria. The study is a narrative implementation review of evidence published between 2020 and 2022, drawing together modelling work, programme evaluations, population surveys, qualitative research, audit reports and international guidance. Rather than treating testing, tracing and isolation as separate activities, it follows them as one connected pathway that begins when a person seeks a test and ends when they and their contacts complete isolation, and it interprets the obstacles along that pathway through an established implementation science framework. The review shows that contact tracing can meaningfully slow transmission, but only when it is fast enough to reach people within a few days of symptom onset and thorough enough to capture most of their contacts. In routine practice these conditions were seldom achieved. Modest losses at each stage of the pathway compounded one another, so that relatively few of the people who needed to stay at home were reached in time and remained isolated for the full period. The evidence suggests that these shortfalls reflected the systems in which health workers operated more than the effort of the workers themselves. Testing and reporting were often too slow to keep pace with the virus, clinics were frequently disconnected from the public health services responsible for following up contacts, and staff were stretched by rising caseloads. At the same time, fear of stigma, mistrust of authorities and the economic cost of staying home discouraged many people from disclosing contacts or completing isolation, and these pressures fell hardest on low-income households, informal workers and people living in crowded housing. Programmes performed better when the process began at the point of testing, when community health workers and trusted local voices carried the message, when clinics kept in touch with patients during isolation, and when practical and financial help made staying home a realistic choice. The review concludes that the weakness of contact tracing during COVID-19 lay mainly in its implementation rather than its underlying logic. Community outpatient clinics are well placed to close much of this gap, because they occupy the stages where the pathway most often broke down and they hold the trust of the communities they serve. Realising this potential requires that clinics be given a clear role in outbreak response, connected securely to public health information systems, adequately staffed and supplied, and supported by policies that protect people from the costs of isolation. In settings such as Nigeria, where primary health care centres already anchored much of the tracing effort and informal work is widespread, these lessons are especially pertinent to preparing for future respiratory pandemics.

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INTRODUCTION

Contact tracing pairs the identification and isolation of infected people with the identification, notification and quarantine of those they may have exposed. It is a long-established public health tool for tuberculosis, sexually transmitted infections, Ebola and measles, and international and regional health agencies positioned it as a core component of the COVID-19 response alongside testing and isolation (Africa Centres for Disease Control and Prevention, 2020; European Centre for Disease Prevention and Control, 2020; World Health Organization, 2021a, 2021b, 2022; World Health Organization Regional Office for Africa, 2020). National guidance translated these principles into operational plans covering case interviews, contact monitoring, confidentiality, support for people in isolation and workforce scale-up (Centers for Disease Control and Prevention, 2020). The underlying logic is simple: if infected people and their contacts are separated from others before they transmit, chains of transmission are cut (Rajan et al., 2020).

SARS-CoV-2 posed an unusually difficult challenge for this logic. A large share of transmission occurs before symptoms appear or from people who never develop symptoms, so the window in which tracing can prevent onward spread is short (Ferretti et al., 2020; Hellewell et al., 2020). Modelling published early in the pandemic showed that each day of delay between symptom onset, testing, result, interview and contact notification erodes much of the potential benefit (Juneau et al., 2020; Kretzschmar et al., 2020). Transmission was also highly overdispersed, with a minority of cases responsible for most onward infections, which has implications for how tracing should be directed (Endo et al., 2020; Laxminarayan et al., 2020). Finally, tracing depends on human behaviour at several points: people must seek testing, disclose their contacts, answer calls from tracers, and then remain at home for days while often losing income (Rubin et al., 2020; Webster et al., 2020).

Community outpatient clinics occupy a strategic position in this chain. In many health systems, and particularly in sub-Saharan Africa and in lower-income communities elsewhere, primary health care centres and community clinics were where symptomatic people first presented, where swabs were taken, and where trusted health workers could explain what isolation meant (Goodyear-Smith et al., 2022; Krist et al., 2020; Rawaf et al., 2020). Yet much of the published evaluation literature describes centralised call-centre tracing run by health departments, and international surveys found that testing and tracing were frequently disconnected from primary care (Kinder et al., 2021). The specific contribution of clinics, and the barriers they faced, is therefore less often examined directly.

This review asks four questions. (1) What is the evidence that contact tracing and isolation reduced

COVID-19 transmission? (2) How did tracing and isolation actually perform when implemented at scale? (3) What role did primary care and community clinics play? (4) What implementation barriers and facilitators explain the gap between potential and observed effectiveness, and what do they imply for community outpatient clinics, with particular attention to Nigeria and comparable settings?

Previous reviews have mostly assessed the effectiveness of tracing or the engagement of the public with centralised programmes (Juneau et al., 2020; Megnin-Viggars et al., 2020; Thomas Craig et al., 2021). This review adds an implementation perspective centred on community outpatient clinics: it brings together effectiveness, programme performance and adherence evidence along a single cascade, maps the barriers at each step to CFIR domains, and gives specific attention to sub-Saharan Africa, where primary health care centres carried much of the operational burden of the response.

2. RESEARCH METHOD

2.1 Study design

This is a narrative implementation review. It was designed to synthesise evidence for practice and policy rather than to provide a pooled estimate of effect, and it did not follow a registered systematic review protocol. The approach suits a heterogeneous evidence base that combines mathematical models, surveillance analyses, cohort studies, surveys, qualitative studies, audit reports and programme descriptions (Megnin-Viggars et al., 2020; Thomas Craig et al., 2021).

2.2 Information sources and search

Sources included PubMed/MEDLINE, the medRxiv preprint server, the CDC Morbidity and Mortality Weekly Report, Cochrane rapid reviews, WHO, ECDC, Africa CDC and national guidance, UK parliamentary and audit reports, and the reference lists of included reviews. Search terms combined COVID-19 or SARS-CoV-2 with contact tracing, case investigation, isolation, quarantine, adherence, compliance, primary care, outpatient, community health workers and community health. The core evidence window was January 2020 to December 2022.

To inform the discussion of health system capacity, a supplementary set of sources was drawn from a consolidated institutional reference list. These covered diagnostic and laboratory infrastructure, health data governance and privacy, public health surveillance analytics, operations and workflow improvement, supply chain management, workforce safety and organisational learning, and communication. All were published in or before 2022; several come from adjacent disciplines and were used to interpret system-level barriers and to inform

recommendations, not as evidence of COVID-19 tracing effectiveness, and they are identified as such in the text where relevant.

2.3 Eligibility criteria

- Studies or reports assessing the effectiveness of contact tracing, quarantine or isolation for COVID-19 in community settings (modelling, observational, quasi-experimental, systematic reviews).
- Analyses reporting real-world performance of case investigation, contact tracing or isolation (for example interview completion, contact disclosure, timeliness, adherence).
- Studies describing the role of primary care, community health centres or community health workers in testing, tracing, isolation support or remote monitoring.
- Studies describing barriers or facilitators to implementation, including stigma, trust, privacy, financial and housing constraints, workforce and information systems.
- Hospital in-patient and long-term care facility outbreak investigations were excluded unless they informed community practice.

2.4 Conceptual model: the clinic-anchored TTIS cascade

We frame contact tracing and isolation as a cascade, similar to the HIV care cascade, in which each step must succeed for the next to matter (Hargreaves et al., 2020). Losses compound multiplicatively, so modest shortfalls at several steps can leave very little of the intended effect. Table 1 sets out the cascade, the role a community outpatient clinic can play at each step, and an indicator that can be monitored. Thinking about the cascade as a sequence of operational processes also invites the use of process improvement and workflow redesign methods from operations management, which identify bottlenecks and cycle-time losses in multi-step service processes (Oyeleye et al., 2022), and approaches to coordinating multiple stakeholders around shared processes are relevant to the interface between clinics and public health authorities (Eyetezmitan et al., 2020).

2.5 Implementation frameworks

Barriers and facilitators were mapped to the domains of the Consolidated Framework for Implementation Research (CFIR): intervention characteristics, outer setting, inner setting, characteristics of individuals, and process (Damschroder et al., 2009). The 2022 update of CFIR, which strengthens attention to equity and to the recipients of an intervention, informed the treatment of patient-level barriers (Damschroder et al., 2022) to the recipients of an intervention, informed the treatment of patient-level barriers (Damschroder et al., 2022). Outcomes were described using RE-AIM (reach, effectiveness, adoption, implementation, maintenance) (Glasgow et al., 1999) and the implementation outcomes taxonomy of Proctor et al. (2011), particularly

Table 1. The test, trace, isolate and support cascade and the role of community outpatient clinics

Cascade step	What must happen	Role of the community outpatient clinic	Example indicator
1. Case detection	Symptomatic or exposed person is tested promptly	Triage, same-day testing, low barriers to access	Median days from symptom onset to test
2. Result and notification	Result reaches the patient and public health quickly	Rapid antigen tests on site; direct electronic reporting	Proportion of results reported within 24 hours
3. Case interview	Case is reached and interviewed	Interview started at the point of testing, by a known clinician	Proportion of cases interviewed
4. Contact elicitation	Case names close contacts	Private setting, rapport, reassurance on confidentiality	Contacts named per case; proportion naming none
5. Contact notification	Contacts are reached and advised	Local knowledge, community health worker outreach	Proportion of contacts reached within 24 to 48 hours
6. Isolation and quarantine	Cases and contacts stay home for the required period	Clear counselling, written guidance, medical certificates	Self-reported or verified adherence
7. Support and monitoring	Practical, financial and clinical needs are met	Referral to income, food and housing support; remote clinical monitoring	Proportion of those in need who receive support

Source: authors' synthesis, informed by WHO and ECDC guidance (European Centre for Disease Prevention and Control, 2020; World Health Organization, 2021b) and the find, test, trace, isolate and support framework (Rajan et al., 2020).

acceptability, feasibility, fidelity, penetration and sustainability.

Behavioural barriers were also considered through the lens of behavioural science frameworks applied during the pandemic (Michie & West, 2020; Thorne et al., 2022; Van Bavel et al., 2020).

2.6 Data extraction and synthesis

Findings were extracted into a structured matrix covering setting, design, cascade step, outcome and reported barriers. Synthesis was thematic and organised by cascade step, then by CFIR domain. Where quantitative outcomes were reported, ranges are presented rather than pooled estimates because definitions, populations and time periods varied substantially.

3. RESULTS AND DISCUSSION

3.1 Effectiveness of contact tracing and isolation

Modelling evidence

Modelling studies provide the clearest picture of what tracing can achieve under specified conditions. Early branching-process models showed that controlling most outbreaks required tracing more than 70% of contacts when the basic reproduction number was 2.5, and more than 90% when it was 3.5, with control becoming unlikely once pre-symptomatic transmission was substantial (Hellewell et al., 2020). Ferretti et al. (2020) concluded that because much transmission occurs before symptoms, manual tracing alone was too slow and that near-instant notification would be needed to keep the reproduction number below one. Keeling et al. (2020) estimated that effective tracing could leave fewer than one in six cases generating untraced infections, but at the cost of tracing around 36 people per case, a burden that could overwhelm systems when incidence rose.

Using UK social contact data, Kucharski et al. (2020) estimated that self-isolation combined with manual tracing of all contacts reduced transmission by about 64%, compared with 37% for isolation with household quarantine only and 47% for app-based tracing alone. An agent-based model of the Boston area similarly found that strong testing, tracing and household quarantine could keep cases within health system capacity during reopening (Aleta et al., 2020). A systematic review of 32 studies (14 observational and 18 modelling) concluded that practitioners have roughly 2 to 3 days from a case's symptom onset to isolate the case and quarantine at least 80% of contacts, and that tracing with delays of 4 to 5 days or more, or with fewer than 60% of contacts quarantined, may contribute little (Juneau et al., 2020). Kretzschmar et al. (2020) found that minimising testing delay had the largest single effect, and that when testing and tracing together took three days or more, even complete coverage did not bring the reproduction number below one.

Two further modelling insights are relevant to clinics. First, because transmission was overdispersed, tracing backwards to find the source case identified clusters with three to ten times more infections than average, and combining backward with forward tracing could double or triple the proportion of cases averted (Bradshaw et al., 2021; Endo et al., 2020). Second, shorter quarantine combined with testing could approach the benefit of a full 14-day quarantine: a

7-day quarantine ending in a negative test averted an estimated 54% of onward transmission, compared with 59% for 14 days (Quilty et al., 2021). A Cochrane rapid review, based mainly on modelling, estimated that quarantine alone could avert 44% to 96% of cases compared with no measures, with greater benefit when combined with other interventions (Nussbaumer-Streit et al., 2020).

Observational and quasi-experimental evidence

Observational studies support an association between tracing and better epidemic control, but because tracing was nearly always deployed alongside other measures, its independent contribution is difficult to isolate (Juneau et al., 2020; Robert Koch Institute, 2022; Thomas Craig et al., 2021). Experiences in East Asia illustrate what high-performing systems achieved. In Shenzhen, cases found through contact tracing were isolated on average 1.9 days earlier than those found through symptom-based surveillance (Bi et al., 2020). In Singapore, contact tracing first identified 53% of the first 100 cases, and the average time from symptom onset to isolation for local cases fell from 18 days to about 3 days (Ng et al., 2020). In Taiwan, no infections occurred among contacts exposed more than five days after the index case's symptom onset, underlining that tracing must focus on the pre-symptomatic and early symptomatic period (Cheng et al., 2020). In South Korea, 11.8% of household contacts tested positive compared with 1.9% of non-household contacts, supporting prioritisation of household members (Park et al., 2020). Vietnam quarantined around 200,000 people based on epidemiological risk rather than symptoms during its first 100 days, which captured many asymptomatic infections (Pham et al., 2021).

Quasi-experimental evidence offers stronger causal inference. In England in late September and early October 2020, a spreadsheet error delayed the referral of about 16,000 positive cases to the tracing system. Exploiting this natural experiment, Fetzner & Graeber (2021) estimated that timely tracing was associated with substantially fewer new infections and deaths in the following six weeks. Household transmission data reinforce the importance of speed: in intensive household studies about three quarters of secondary infections were identified within five days of the index case's illness onset (Grijalva et al., 2020), and a meta-analysis of 54 studies estimated a household secondary attack rate of about 17% (Madewell et al., 2020).

Digital contact tracing

Digital exposure notification was proposed as a way to overcome the speed limits of manual tracing (Ferretti et al., 2020). An analysis of the NHS COVID-19 app estimated that it averted a substantial number of cases in late 2020, with larger effects where uptake was higher (Wymant et al., 2021), and early Swiss data showed that

app notifications reached contacts who later tested positive (Salathé et al., 2020). A controlled population experiment on the Spanish

island of La Gomera found that at least a third of residents adopted the app during the trial (Rodríguez et al., 2021). Other evaluations were less encouraging. In New South Wales, only 22% of cases used the national app, which identified very few additional contacts beyond those found by conventional tracing (Vogt et al., 2022), and a Cochrane rapid review rated the evidence for digital tracing as low or very low certainty (Anglemyer et al., 2020). The consensus is that digital tools can complement but not replace manual tracing and clinical follow-up (Kleinman & Merkel, 2020).

3.2 Real-world performance of the tracing cascade

United States

Surveillance analyses from the United States provide some of the most detailed data on how the cascade performed. Across 14 health departments in mid-2020, a median of 57% of cases were interviewed within 24 hours of being reported, only about one contact was named per case, and 55% of contacts were notified within 24 hours, with heavier caseloads associated with poorer timeliness (Spencer et al., 2021). In two North Carolina counties, investigation began within a median of 3 to 4 days of specimen collection, and 48% and 35% of interviewed patients named no contacts (Lash et al., 2020). A larger analysis of 74,185 cases across 11 states found that about two of every three infected people were either not interviewed or named no contacts, with only 0.5 contacts monitored per case (Lash et al., 2021). In Washington State, only 33% to 45% of interviewed cases reported any contacts (Bonacci et al., 2021).

City programmes reported similar patterns. In San Francisco during shelter-in-place, more than 80% of cases and contacts were reached but only about half of cases named contacts, and the median interval from symptom onset to contact notification was about six days (Sachdev et al., 2021); fewer than half of traced contacts were tested (Reid et al., 2021). New York City's programme reached most cases but had a median of 4.7 days from symptom onset to completed interview and 1.4 contacts per case (Blaney et al., 2022). A volunteer-based programme in New Haven reached only 48% of cases and 28% of named contacts, with longer delays among older and Black residents (Shelby et al., 2021).

United Kingdom and Europe

In England, the National Audit Office reported that between May and November 2020 NHS Test and Trace reached and advised to self-isolate about two thirds of identified close contacts, below the 80% benchmark, while the share of test results returned within 24 hours fell sharply during the autumn surge (National Audit Office, 2020). Contact reach later improved to above 80%, but at very high cost and with low utilisation of contact

Table 2. Summary of key effectiveness evidence

Study	Design	Main finding	Relevance to clinics
Hellewell et al. (2020)	Branching-process model	More than 70% to 90% of contacts must be traced, depending on transmissibility	Completeness of contact elicitation matters
Juneau et al. (2020)	Systematic review, 32 studies	Needs 2 to 3 days and about 80% of contacts quarantined; little benefit below 60% or with 4 to 5 day delays	Clinic workflows should be built around speed and completeness
Kretzschmar et al. (2020)	Stochastic model	Testing delay is the most important driver; optimised tracing can prevent up to about 80% of transmissions	Point-of-care testing and same-day interviews give the largest gains
Kucharski et al. (2020)	Mathematical model	Isolation plus manual tracing reduced transmission by about 64%	Manual, relationship-based tracing remains central
Endo et al. (2020); Bradshaw et al. (2021)	Models of backward tracing	Backward tracing can double or triple cases averted	Clinicians can ask where patients may have been infected
Quilty et al. (2021)	Model of quarantine strategies	7 days plus negative test averted 54% vs 59% for 14 days	Shorter, test-supported quarantine is easier to adhere to
Fetzer & Graeber (2021)	Natural experiment (England)	Delayed referral was followed by excess infections and deaths	Reporting delays between testing site and tracers have real costs
Wymant et al. (2021); Vogt et al. (2022)	App evaluations	Benefit depends on uptake; low uptake gives little added value	Digital tools complement clinic-based tracing
Bodas & Peleg (2020b)	Population survey (Israel)	Intended compliance 94% with wage compensation vs under 57% without	Isolation support determines whether tracing reduces contact

centre staff (National Audit Office, 2021). The Public Accounts Committee concluded that there was no clear evidence that the programme had made a measurable difference to the course of the epidemic (House of Commons Committee of Public Accounts, 2021). European guidance set targets for reaching cases and contacts within 24 hours and emphasised that halving the delay from onset to tracing could greatly reduce transmission before quarantine (European Centre for Disease Prevention and Control, 2020).

Africa and other low- and middle-income settings

Evidence from Africa describes strain under very different resource conditions. Nigeria's response, coordinated by the Nigeria Centre for Disease Control, increased the proportion of contacts followed up from 71% at the start of lockdown to 91% by the end of May 2020 (Dan-Nwafor et al., 2020). However, case numbers rose sharply after lockdown was relaxed, and transmission shifted from imported cases to community spread (Amzat et al., 2020). Press reporting from Lagos in mid-2020 described a tracing team based at a primary health care centre working with roughly 200 tracers for a population of about 25 million, alongside low testing rates and people avoiding tracers because of stigma (Reuters, 2020). A comparative perspective on Nigeria, Rwanda, South Africa and Uganda identified overwhelming workload for health workers, misinformation and stigma, and poorly sustained adherence to isolation and quarantine as key challenges (Kilmarx et al., 2021).

Other African programmes showed what decentralised approaches could achieve. Ghana's enhanced contact tracing, which tested people within two kilometres of confirmed cases using geographic information systems, quadrupled weekly case detection in urban districts (Kenu et al., 2022). Rwanda used contact tracing data to identify the household and workplace relationships associated with secondary infection (Semakula et al., 2021).

Box 1. An illustrative leaky cascade

Illustration (not a measured estimate)

Suppose 70% of cases are interviewed, 55% of those interviewed name at least one contact, 60% of named contacts are reached, and 50% of those reached fully quarantine. Multiplying these steps gives $0.70 \times 0.55 \times 0.60 \times 0.50$, or roughly 12%. Each step falls within the ranges reported above (Lash et al., 2021; Shelby et al., 2021; Smith et al., 2021a; Spencer et al., 2021; Steens et al., 2020), yet only around one in eight of the intended quarantine effect is realised, and this is before accounting for delay. Improving every step by ten percentage points raises the product to roughly 20%, showing why system-wide fixes outperform heroic effort at any single step.

In Cape Town, community health worker teams screened over 70,000 people in three weeks but faced difficulties with staffing, transport, protective

equipment, data capture and community distrust (David & Mash, 2020). In India, tracing of more than half a million contacts in two states showed that most cases infected no one while a small minority caused most infections (Laxminarayan et al., 2020). Kenyan modelling suggested that tracing and distancing alone would not control spread unless the time from symptoms to isolation was short (Wagner et al., 2020). Lessons from the West African Ebola epidemic are also relevant: in Liberia, high completion of contact follow-up coexisted with very few new cases being found through tracing, showing that process measures can mask poor system performance (Swanson et al., 2018).

3.3 Isolation and quarantine adherence

Tracing reduces transmission only if notified people actually separate from others. A rapid review conducted early in the pandemic found that quarantine adherence varied widely, from almost none to over 90%, and depended on knowledge of the rules, social norms, perceived risk and benefit, and practical barriers such as loss of income and running out of supplies (Webster et al., 2020). In the UK, pooled data from 37 nationally representative surveys showed that only about half of respondents could identify the main symptoms of COVID-19, and that duration-adjusted full self-isolation among people reporting symptoms was 42.5% (Smith et al., 2021a). An earlier UK survey found that three quarters of people with symptoms, or living with someone with symptoms, had left home in the previous 24 hours (Smith et al., 2020), and fewer than 60% of adults appeared to know all the main self-isolation rules (Smith et al., 2021b). In Norway, only 42% of people asked to quarantine or isolate reported full adherence, falling over time and much lower among those without symptoms (Steens et al., 2020).

Financial security emerged as a decisive determinant. In an Israeli population survey, intended compliance with quarantine was 94% when respondents assumed lost wages would be compensated, but fell below 57% without compensation (Bodas & Peleg, 2020b); the gap narrowed as the epidemic intensified, and trust in the Ministry of Health predicted compliance even without compensation (Bodas & Peleg, 2020a). In the UK, people in the lowest income groups were much less able to work from home and less able to self-isolate (Atchison et al., 2021). Qualitative work identified a pattern of necessity-driven partial adherence, particularly among low-income and minority ethnic groups, that could be reduced by practical and financial support (Denford et al., 2021). In the United States, states that gained access to emergency paid sick leave saw an estimated 400 fewer confirmed cases per state per day (Pichler et al., 2020). Behavioural scientists argued that low isolation adherence reflected lack of resources rather than pandemic fatigue (Reicher & Drury, 2021), and that support enabling people to isolate should be treated as

part of the intervention rather than an optional extra (Bonell et al., 2020; Michie & West, 2020; Patel et al., 2021).

Other determinants include confidence in government, which predicted later adherence in a large UK panel (Wright et al., 2021), and individual characteristics such as younger age and risk-taking, which were associated with lower compliance (Wright et al., 2022). Quarantine also carries psychological costs, including stress, confusion and anger, which are worse with longer duration, poor information and financial loss (Brooks et al., 2020). People living with serious mental illness may also need practical help with meals, medication and other activities of daily living while isolated, and treating that support as part of clinical care rather than an optional extra makes isolation more achievable for them (Osinem et al., 2021). Housing is a further structural constraint: across US counties, poorer housing conditions including overcrowding were associated with substantially higher COVID-19 incidence and mortality (Ahmad et al., 2020), and poverty and insecure work made isolation hardest for those already most disadvantaged (Patel et al., 2020). In agrarian and informal economies, the links between household income stability and food security observed in agricultural research help explain why lost days of work translate quickly into household hardship during isolation (Michael & Ogunsola, 2021b).

3.4 The role of primary care and community outpatient clinics

Primary care was widely described as the first line of defence during COVID-19 (Krist et al., 2020). Cross-country analyses found that countries whose pandemic plans included primary care and which had universal coverage performed better, while fee-for-service practices faced financial losses and closures that limited their capacity (Huston et al., 2020). A study of health system resilience across 28 countries identified community engagement and coordinated service delivery as features of effective responses (Haldane et al., 2021). Lessons from past epidemics pointed to the need for closer collaboration between public health and primary care and for clearly defined primary care roles (Desborough et al., 2021). In practice, however, primary care professionals worldwide reported that policymakers gave them little guidance on their pandemic role (Rawaf et al., 2020), and a survey of more than 1,000 primary care stakeholders in 111 countries found that testing and contact tracing were largely disconnected from primary care, leaving family doctors unable to follow up patients (Kinder et al., 2021).

Where primary care was mobilised, it contributed at several points in the cascade. In the United States, federally funded community health centres performed more than three million SARS-CoV-2 tests in four months and disproportionately reached Hispanic and other underserved patients (Romero et al., 2020). In Italy, general practitioners described the first wave as a period of unclear

guidance, shortages of protective equipment and poor coordination with public health services (Kurotschka et al., 2021). In Barcelona, a primary care centre conducted structured telephone follow-up of quarantined close contacts (Baena-Diez et al., 2021). Comparisons across Australia, Nigeria, South Africa and Egypt showed that Australia and Nigeria mobilised primary care, while all four countries rapidly adopted telehealth and emphasised integrating primary care with public health for testing and surveillance (Goodyear-Smith et al., 2022). European primary care professionals described rapid shifts to remote consultation and new models of COVID care, held back by unclear guidance, shortages of protective equipment and reimbursement uncertainty (Wanat et al., 2021).

Clinics also supported people during isolation. Guidance on home pulse oximetry and virtual wards set out how isolated patients could be monitored remotely so that deterioration was detected early (Greenhalgh et al., 2021). A systematic review of virtual ward models found them feasible across several countries, although evidence on safety and cost-effectiveness was limited (Vindrola-Padros et al., 2021), and a national evaluation in England found a non-significant reduction in mortality associated with higher coverage of remote monitoring (Sherlaw-Johnson et al., 2022). A multisite study in London found home oximetry to be a safe way of monitoring patients with COVID-19 in the community (Clarke et al., 2021). Rapid antigen tests, with high specificity and moderate sensitivity that is best in the first week of symptoms, made same-visit diagnosis feasible in outpatient settings (Dinnes et al., 2022).

3.5 Implementation barriers mapped to CFIR

Table 3 maps the barriers identified across the reviewed literature to CFIR domains and indicates how each manifests in a community outpatient clinic. The sections that follow examine the most consequential barriers in more detail.

Testing, diagnostic and supply capacity

Because testing delay is the strongest determinant of tracing effectiveness (Kretzschmar et al., 2020), the availability, location and throughput of laboratories largely set the ceiling on what clinic-based tracing can achieve.

Table 3. Implementation barriers by CFIR domain

CFIR domain	Barrier	How it appears in community outpatient clinics	Evidence
Intervention characteristics	Complexity and changing guidance	Frequent changes to isolation periods, contact definitions and testing criteria confused staff and patients	(Smith et al., 2021b; Wanat et al., 2021; World Health Organization, 2021b)

CFIR domain	Barrier	How it appears in community outpatient clinics	Evidence
Intervention characteristics	Time-critical design	Value is lost if results or referrals are delayed beyond 2 to 3 days	(Fetzer & Graeber, 2021; Juneau et al., 2020; Kretzschmar et al., 2020)
Outer setting	Loss of income during isolation	Daily-wage and informal workers decline testing or leave isolation early	(Atchison et al., 2021; Bodas & Peleg, 2020b; Kilmarx et al., 2021; Pichler et al., 2020)
Outer setting	Stigma, misinformation and distrust	Patients withhold contacts or avoid clinics known to report cases	(Ezeibe et al., 2020; Megnin-Viggars et al., 2020; Roozenbeek et al., 2020; Thorneloe et al., 2022)
Outer setting	Crowded or shared housing	Household contacts cannot be separated; isolation at home is impractical	(Ahmad et al., 2020; Emeruwa et al., 2020; Patel et al., 2020)
Outer setting	Weak policy integration of primary care	Clinics excluded from tracing workflows and data flows	(Huston et al., 2020; Kinder et al., 2021; Rawaf et al., 2020)
Inner setting	Workforce capacity and wellbeing	Clinicians add interviews and follow-up calls to existing workloads; tracers fall ill or burn out	(Bryant-Genevier et al., 2021; Nguyen et al., 2020; Watson et al., 2020)
Inner setting	Fragmented information systems	Paper registers, duplicate entry and no direct link to public health databases slow notification	(Lash et al., 2021; Mbonu et al., 2020b; Valencia et al., 2022)
Inner setting	Testing and supply capacity	Limited test kits and slow laboratory turnaround delay every downstream step	(Aminu-Ibrahim et al., 2018, 2022; National Audit Office, 2020; Ogunwole et al., 2021)
Individuals	Knowledge and skills	Staff redeployed without training in interviewing, confidentiality or counselling	(Obriki et al., 2022a; Westfall et al., 2022)
Individual	Patient	Patients do not	(Amara et al.,

CFIR domain	Barrier	How it appears in community outpatient clinics	Evidence
Individuals	Knowledge and beliefs	recognise symptoms or understand what full isolation requires	2022; Smith et al., 2021a, 2021b)
Process	Weak handover between clinic and public health	Unclear responsibility for interviewing, notifying contacts and checking adherence	(Desborough et al., 2021; Lash et al., 2020)
Process	Limited monitoring and feedback	Clinics rarely receive data on whether their referrals led to contacts being reached	(Sanni & Atima, 2021; Spencer et al., 2021; Swanson et al., 2018)

In England, the share of results returned within 24 hours fell dramatically as demand surged in autumn 2020 (National Audit Office, 2020), and in Nigeria low testing rates made tracers' work harder (Amzat et al., 2020; Reuters, 2020). Across nine sub-Saharan African countries, testing rates differed by more than thirtyfold during 2020 (Haider et al., 2020).

A body of health infrastructure literature helps explain these constraints. Work on resource-constrained health systems has argued that sustainable diagnostic laboratory infrastructure, rather than ad hoc emergency expansion, is needed to support routine and surge demand (Aminu-Ibrahim et al., 2018), and that extending diagnostic access to underserved and rural regions depends on deliberate infrastructure investment (Aminu-Ibrahim et al., 2020). Laboratories designed for pandemic preparedness, with appropriate biosafety, workflow and scalable capacity, can shorten turnaround when demand spikes (Aminu-Ibrahim et al., 2022). Laboratory spatial planning influences throughput and safety (Ogbete et al., 2018), regulatory-compliant design is essential for molecular and pathology work (Ogbete et al., 2019). Even where equipment and space exist, the adoption of newer diagnostic techniques in resource-limited laboratories is slowed by shortages of trained staff, gaps in quality assurance and unreliable reagent supply, barriers documented in oncology diagnostics that apply equally to scaling up outbreak testing (Abdulrazaq et al., 2021). Specimen collection networks, analogous in design to blood collection networks, depend on standardised operational planning (Ogbete et al., 2022). Delivering such facilities quickly requires effective capital project and programme management across multiple sites (Aminu-Ibrahim et al., 2019, 2021) and risk-managed

construction approaches for highly regulated facilities (Ogbete et al., 2021). Considerations of energy efficiency and sustainable materials also affect the long-term viability of diagnostic facilities (Ogbete et al., 2020).

Supply chains were a parallel constraint. Shortages of test kits, reagents and protective equipment were reported by primary care professionals across Europe (Wanat et al., 2021) and by community screening teams in South Africa (David & Mash, 2020). Literature on supply chain management in other critical infrastructure sectors highlights approaches that transfer to health commodities: supply chain risk management (Agbabiaka et al., 2019), resilience frameworks for critical infrastructure (Ogunwale et al., 2021), agile digital supply chain transformation with embedded risk controls (Mbonu et al., 2020a), materials readiness planning (Okonkwo et al., 2021), and inventory availability models that prevent stock-outs (Okonkwo et al., 2018). For clinics, the practical implication is that testing cannot be faster than the slowest link in the supply of consumables.

Information systems, data governance and privacy

Clinic-to-public-health reporting relied in many places on paper registers, spreadsheets or disconnected systems. The English spreadsheet error is the most dramatic example of how fragile data pipelines can undermine tracing (Fetzer & Graeber, 2021). In the Americas, the WHO-supported Go.Data platform enabled large-scale case and contact management, but its value depended on integration with national surveillance systems (Valencia et al., 2022). Standardising reporting and decision workflows improves data quality and management visibility (Alieme et al., 2022), and dashboard frameworks can give managers timely visibility of key indicators (Sanni & Atima, 2021). Translating frequently changing regulatory requirements into routine compliance workflows is a parallel challenge in other sectors (Eyetsemitan et al., 2021), and one that clinics faced each time isolation and testing guidance changed.

Confidentiality is equally important. Concern about privacy was one of the main barriers to engagement with contact tracing in a rapid review of previous outbreaks (Megnin-Viggars et al., 2020), and privacy and cybersecurity concerns, together with low trust in government, were the leading reasons people gave for not installing tracing apps (Altmann et al., 2020; Williams et al., 2021). Ethical analyses argued that tracing technologies should meet tests of necessity, proportionality, scientific validity and time limitation, with transparent oversight (Kleinman & Merkel, 2020; Morley et al., 2020; Parker et al., 2020). Data governance frameworks from health and other regulated sectors offer practical safeguards: privacy-preserving analytics under data protection law (Atakpa & Abolaji, 2022), comparative governance frameworks for data verification, risk screening and confidentiality in

health and financial systems (Peteranaba et al., 2022), legal and ethical risk modelling for data protection (Mbonu et al., 2018), comparative analysis of data protection regulations across jurisdictions (Mbonu et al., 2019a), data protection impact assessment (Mbonu et al., 2022a), identity and access management that limits who can view sensitive records (Mbonu et al., 2020b, 2022b), and audit logging with automated incident response to detect inappropriate access (Mbonu et al., 2019b).

Workforce capacity, safety and wellbeing

The scale of the workforce needed for comprehensive tracing was large. In the United States, planners estimated a need for about 100,000 additional tracers (Watson et al., 2020), and public health associations proposed a baseline of 30 tracing staff per 100,000 population (National Association of County and City Health Officials, 2020). The WHO African Region recommended a ratio of one tracer per ten contacts (World Health Organization Regional Office for Africa, 2020), far above the capacity reported in Lagos (Reuters, 2020). Diverting community health workers to tracing could also reduce routine essential services (Bhaumik et al., 2020).

Training could be delivered quickly: an evaluation of California's virtual training academy found that lay trainees felt nearly as prepared as those with public health backgrounds (Westfall et al., 2022). The workforce, however, carried substantial risk. Front-line health workers had a markedly higher risk of testing positive than the general community (Nguyen et al., 2020), health workers exposed to COVID-19 reported high rates of depression, anxiety and distress (Lai et al., 2020), and more than half of US public health workers surveyed in 2021 reported symptoms of at least one mental health condition, with most feeling overwhelmed by workload (Bryant-Genevier et al., 2021). Volunteer tracers in one programme stayed for a median of only four weeks (Shelby et al., 2021).

Occupational safety research from other high-risk sectors offers transferable lessons on protecting and sustaining such a workforce. Leadership-driven safety culture in large workforces (Obogo et al., 2019), visible supervisory presence (Obriki & Arumosoye, 2019), structured workforce safety training (Obriki et al., 2022a), and models for institutionalising protective practices across project-based organisations (Obriki & Arumosoye, 2021) are all relevant to rapidly assembled tracing teams. Where tracing was outsourced to contractors, as in England (National Audit Office, 2020), governance of contractor performance and compliance becomes important (Arumosoye & Obriki, 2020; Obogo et al., 2021c). Near-miss and hazard reporting systems (Arumosoye & Obriki, 2019; Obogo et al., 2021a), incident prevention models

(Obogo et al., 2021b), internal quality audit systems (Obogo et al., 2020a), and organisational learning-based maturity models (Arumosoye & Obriki, 2021) suggest ways for tracing programmes to learn from errors such as missed contacts or delayed referrals. Frameworks explaining human error (Obriki & Arumosoye, 2020) and the recurrence of unsafe behaviours (Obriki & Arumosoye, 2022) help explain lapses in infection prevention among overloaded staff, while data-driven occupational risk control (Obriki & Arumosoye, 2018), critical reviews of safety management systems (Obogo et al., 2020b), safety governance for large facilities (Obogo et al., 2022) and emergency preparedness systems (Obriki et al., 2022b) align with infection prevention and surge planning in busy clinics.

Trust, stigma, misinformation and communication

Fear of stigma, mistrust and unmet information needs reduced engagement with contact tracing across outbreaks (Megnin-Viggars et al., 2020). In UK focus groups, people who anticipated high costs from isolating were less likely to interpret symptoms as COVID-19 or to share contact details, and distrust of the testing system compounded this (Thorneloe et al., 2022). In Michigan, willingness to participate in tracing was predicted by perceived threat, concern about misinformation and trust in the health system (Amara et al., 2022). Across five countries, people more susceptible to misinformation reported lower compliance with public health guidance, while trust in scientists was protective (Roozenbeek et al., 2020). In Nigeria, political distrust was linked to non-compliance with public health measures and to the spread of COVID-19 (Ezeibe et al., 2020). In Nigeria, stigma led some people to avoid tracers altogether (Kilmarx et al., 2021; Reuters, 2020).

WHO framed the spread of false information as an infodemic requiring active management (Zarocostas, 2020), and behavioural scientists emphasised trust, clear explanations, collective identity and practical support as foundations for public health campaigns (Bonell et al., 2020; Van Bavel et al., 2020). Experience from HIV underlines the need to engage affected communities and address stigma and structural drivers (Hargreaves et al., 2020). Communication practice from other sectors also offers tools: integrated communication strategies coordinate messages across channels (Agyei et al., 2018), and audience segmentation allows messages to be tailored to groups with different concerns (Atima et al., 2022). In emerging markets, mobile network coverage shapes which digital channels can reach rural populations (Sanni et al., 2020).

Socioeconomic and structural barriers

COVID-19 has been described as a syndemic interacting with chronic disease and social determinants of health (Bambra et al., 2020). Racial and ethnic minority groups in the United States had higher rates of infection, hospitalisation and death, reflecting differences in exposure and access to

care (Abedi et al., 2021; Mackey et al., 2021; Tai et al., 2021). Mobility network models showed that disadvantaged groups could not reduce their mobility as much as others and visited more crowded places (Chang et al., 2021). Household crowding was associated with markedly higher infection among pregnant women in New York City (Emeruwa et al., 2020), and in England COVID-19 mortality followed patterns of deprivation and was very high among ethnic minorities (Marmot et al., 2020). In sub-Saharan Africa, lockdowns damaged household incomes and livelihoods (Haider et al., 2020), and the informal economy made sustained isolation especially difficult (Kilmarx et al., 2021). Research on rural populations shows that socioeconomic barriers, including cost, connectivity and digital literacy, constrain adoption of new technologies (Michael & Ogunsola, 2022a), which limits the reach of app-based or online tracing tools in such communities, a pattern also observed in the uneven uptake of digital tools for rural livelihoods (Michael & Ogunsola, 2021a). Gender shapes these constraints as well, since women in sub-Saharan Africa are concentrated in informal work and caregiving roles that make isolation harder (Michael & Ogunsola, 2022b), and studies of digital portal adoption in sub-Saharan Africa identify trust, usability and access as determinants of uptake (Agyei et al., 2019).

Process, workflow and coordination

At the process level, clinics often lacked defined roles, standard procedures and feedback loops. Kinder et al. (2021) found that tracing operated largely in parallel to primary care, and Desborough et al. (2021) identified clearly defined primary care roles as a key lesson from earlier epidemics. Operations management research offers practical tools. Standard operating procedures can act as change infrastructure that sustains operational improvements (Agboada et al., 2019), and systematic reviews show their value as strategic assets in small organisations (Eyetsenitan et al., 2022). Lean Six Sigma approaches adapted for resource-constrained organisations can identify and remove waste and delay in multi-step processes (Ambali et al., 2021), and digital transformation in operations management, including automation, analytics and process redesign (Agboada et al., 2018), can reduce duplicated effort. New digital tools also require systematic testing before deployment (Borah et al., 2022). These approaches map directly onto the problems of clinic-based tracing: inconsistent interview procedures, duplicated data entry, and the absence of a feedback loop between referral and outcome.

3.6 Facilitators

Several facilitators recur across settings and are especially relevant to clinics:

- Interview at the point of testing. Beginning case

investigation and contact elicitation during the clinic visit, rather than waiting for a later phone call, removes one delay step and draws on the trust patients place in clinicians (Kretzschmar et al., 2020; Krist et al., 2020).

- **Community health workers and local teams.** Community health workers can support testing, tracing, anti-stigma work and shielding of vulnerable households (Ballard et al., 2020; Bhaumik et al., 2020), and decentralising tracing to local teams helped manage caseloads in Uganda and Rwanda (Kilmarx et al., 2021). Ghana's GIS-linked approach shows the value of spatial targeting (Kenu et al., 2022), consistent with wider use of geographic information systems for infrastructure and service planning (Dagodzo & Ahiaekwe Patrick, 2021).
- **Trusted, consistent communication.** Sustained, multi-platform messaging and community engagement were identified as best practices in African programmes (Kilmarx et al., 2021), and feeling sufficiently informed was associated with better knowledge of isolation rules (Smith et al., 2021b).
- **Practical and financial support.** Assurance of income during isolation was associated with much higher intended compliance (Bodas & Peleg, 2020a, 2020b), paid sick leave reduced cases (Pichler et al., 2020), and WHO guidance recommended food, supplies, paid leave and health monitoring to make quarantine feasible (World Health Organization, 2021a).
- **Remote clinical monitoring.** Telephone follow-up, pulse oximetry and virtual wards allowed clinics to support isolated patients and detect deterioration (Baena-Diez et al., 2021; Clarke et al., 2021; Greenhalgh et al., 2021).
- **Shorter, test-supported quarantine.** Replacing long quarantine with shorter periods plus testing preserves much of the benefit while reducing the burden on contacts (Quilty et al., 2021; Reid et al., 2021).
- **Digital complements.** Exposure notification and text-message follow-up can reduce delay and extend reach where uptake is high (Salathé et al., 2020; Wymant et al., 2021), though they depend on smartphone access and public trust (Altmann et al., 2020; Williams et al., 2021).

3.7 Synthesis of principal findings

The central finding of this review is a gap between what contact tracing can achieve and what it typically achieved. The modelling literature is consistent and specific: tracing works when it is fast and nearly complete (Hellewell et al., 2020; Juneau et al., 2020; Kretzschmar et al., 2020; Kucharski et al., 2020). Surveillance and audit data from multiple jurisdictions show that real programmes were often slower than the modelled window and lost most potential contacts at the interview and disclosure steps (Lash et al., 2021; National Audit Office, 2020; Sachdev et al., 2021; Spencer et al., 2021). Adherence data show that even among

those correctly notified, roughly half did not fully isolate (Smith et al., 2021a; Steens et al., 2020). These losses compound, as Box 1 illustrates, which explains why large investments in tracing workforces did not always translate into visible changes in epidemic curves (House of Commons Committee of Public Accounts, 2021).

This does not mean tracing failed. Quasi-experimental evidence from England shows that disrupting timely tracing had measurable costs (Fetzer & Graeber, 2021), high-performing systems in East Asia demonstrated what was achievable (Bi et al., 2020; Cheng et al., 2020; Ng et al., 2020), and tracing was consistently a high-yield method of finding new cases (Kenu et al., 2022; Lash et al., 2021). Rather, tracing should be judged and resourced as a whole system, not as a workforce target alone, and process measures such as follow-up completion should not be mistaken for system performance (Swanson et al., 2018).

3.8 Positioning community outpatient clinics in the response

Clinics sit at the steps where the cascade leaked most. They can shorten the critical testing delay through on-site rapid testing (Dinnes et al., 2022), begin interviews when patients are present and engaged, and use existing relationships to encourage contact disclosure. They are well placed to identify patients who cannot safely isolate at home, to connect them with support, and to monitor them clinically during isolation (Clarke et al., 2021; Greenhalgh et al., 2021). Community health centres also reached populations that centralised systems struggled to engage (Romero et al., 2020). In settings with thin public health infrastructure, clinics and their community health workers may be the only feasible tracing workforce (Ballard et al., 2020; Kilmarx et al., 2021).

However, adding tracing to clinic workloads without additional staff, training, data links or support budgets risks both poor tracing and disruption of routine services (Bhaumik et al., 2020; Rawaf et al., 2020). The barriers in Table 3 are mostly organisational and structural rather than individual, which means that exhortation of clinic staff is unlikely to fix them. Financial governance matters too: machine learning methods for detecting fraudulent transactions can help protect isolation support payments from misuse without slowing legitimate payments (Atakpa & Abetoh, 2022).

3.9 Equity considerations

The barriers to isolation (income loss, crowded housing, insecure work) and to contact disclosure (stigma, distrust of authorities) are concentrated among lower-income and marginalised groups, who also faced higher COVID-19 risk (Bambra et al., 2020; Chang et al., 2021; Mackey et al., 2021; Marmot et al., 2020). Knowledge of isolation rules was lower in more deprived areas (Smith et al., 2021b), and

volunteer programmes reached older and Black residents less often (Shelby et al., 2021). Tracing programmes that do not address these structural factors may therefore work least well where they are needed most. Clinic-based approaches that link tracing to tangible support, and that use local health workers known to the community, are one way to reduce this inequity (Denford et al., 2021; Patel et al., 2020).

3.10 Implications for Nigeria and comparable settings

For Nigeria and similar settings, several features of the evidence stand out. Primary health care centres were already used as bases for tracing teams in Lagos (Reuters, 2020), and Nigeria was among the countries that mobilised primary care during the pandemic (Goodyear-Smith et al., 2022). The national response achieved high contact follow-up during the early, lower-incidence phase (Dan-Nwafor et al., 2020), but this was difficult to sustain once community transmission was established (Amzat et al., 2020), consistent with regional guidance that comprehensive tracing becomes impractical under widespread transmission (Africa Centres for Disease Control and Prevention, 2020). The large informal workforce makes income support for isolation particularly important (Bodas & Peleg, 2020b; Haider et al., 2020), and stigma remains a significant barrier (Kilmarx et al., 2021). Investment in diagnostic capacity, linked data systems and community health workers would strengthen the role of primary health care centres in future outbreaks (Aminu-Ibrahim et al., 2020; Ballard et al., 2020).

3.11 Implications for pandemic preparedness

For a future pathogen with substantial pre-symptomatic transmission, the lessons are transferable: pre-agree the clinic's role in the tracing workflow, pre-build the data link between clinic testing and public health systems, maintain a trained reserve of community health workers, and legislate isolation support in advance so that it can be activated immediately rather than negotiated during a surge (Desborough et al., 2021; Haldane et al., 2021).

Preparedness also has a physical and analytical dimension. Investment in sustainable diagnostic infrastructure (Aminu-Ibrahim et al., 2018, 2022), with redundancy and surge capacity, would reduce the testing delays that undermined tracing during COVID-19, and integrated national supply and procurement systems would protect the flow of test kits and consumables (Mbonu et al., 2020a; Ogunwole et al., 2021). Lessons from agricultural extension, where trusted local intermediaries drive the adoption of new practices in rural communities (Michael & Ogunsola, 2021c), reinforce the value of community health workers as intermediaries for public health measures.

3.12 Implications for practice

The evidence reviewed points to a set of practical

measures for community outpatient clinics and the public health authorities they work with.

1. Make speed the primary design goal. Offer same-day testing, use rapid antigen tests where appropriate, and aim to complete the case interview before the patient leaves the clinic (Dinnes et al., 2022; Kretzschmar et al., 2020).
2. Define roles clearly. Agree in writing which tasks the clinic performs (testing, interview, initial contact elicitation, counselling, clinical monitoring) and which the public health authority performs (contact notification, follow-up), with named focal persons on both sides (Desborough et al., 2021; Kinder et al., 2021). Document the workflow as a standard operating procedure (Agboada et al., 2019; Eyetsemitan et al., 2022).
3. Connect data systems securely. Replace paper registers and duplicate entry with secure, direct electronic reporting from clinic to the tracing system, protect confidentiality, and give clinics feedback on referral outcomes (Alieme et al., 2022; Mbonu et al., 2020b; Valencia et al., 2022).
4. Train for disclosure. Equip staff with short training in confidential, non-judgmental interviewing and in explaining exactly what isolation and quarantine require (Megnin-Viggars et al., 2020; Westfall et al., 2022).
5. Ask where infection may have occurred. Add a simple backward-tracing question to case interviews to help identify clusters (Bradshaw et al., 2021; Endo et al., 2020).
6. Pair every isolation instruction with a support offer. Screen for income, food, housing and caregiving barriers during the visit and refer to available support; advocate for wage replacement where none exists (Bodas & Peleg, 2020b; Pichler et al., 2020; World Health Organization, 2021a).
7. Monitor isolated patients. Use structured telephone follow-up or remote monitoring, prioritising high-risk patients (Baena-Diez et al., 2021; Clarke et al., 2021; Greenhalgh et al., 2021).
8. Engage communities and counter stigma. Work with community leaders, faith organisations and community health workers to explain the purpose of tracing, address rumours and protect the confidentiality of people who test positive (Agyei et al., 2018; Ballard et al., 2020; Hargreaves et al., 2020).
9. Protect the workforce. Budget for additional staff or community health workers during surges, plan staffing ahead of demand, provide protective equipment, monitor staff wellbeing, and plan cover for staff who fall ill (Bryant-Genevier et al., 2021; Nguyen et al., 2020).
10. Secure supplies. Maintain visibility of test kit and consumable stock and use predictive

procurement to avoid stock-outs (Agbabiaka et al., 2019; Okonkwo et al., 2018).

11. Monitor a small set of cascade indicators weekly, reviewing them on a simple dashboard and using a continuous improvement cycle to address bottlenecks (Table 4) (Ambali et al., 2021; Sanni & Atima, 2021).

3.13 Implications for research

Several evidence gaps remain for future research. First, few studies directly compare clinic-initiated tracing with centralised call-centre tracing on timeliness, contact disclosure and adherence; pragmatic comparative evaluations are needed. Second, the empirical evidence on the independent effect of tracing remains largely observational (Robert Koch Institute, 2022; Thomas Craig et al., 2021), and further natural experiments would strengthen causal inference. Third, most quantitative evidence comes from high-income countries, and implementation research in African primary care settings is needed, including on the use of community health workers and digital tools (Bhaumik et al., 2020; Kilmarx et al., 2021; Valencia et al., 2022). Fourth, the cost-effectiveness of isolation support schemes and their protection against misuse deserve evaluation (Atakpa & Abetoh, 2022; Pichler et al., 2020). Finally, research should test how operations and process improvement methods perform when applied to public health workflows in primary care (Agboada et al., 2018; Ambali et al., 2021).

3.14 Strengths and limitations

This review draws on a broad evidence base spanning modelling, surveillance, audit, qualitative and guidance literature from high-income and low- and middle-income settings, and it uses established implementation frameworks to organise barriers in a way that maps onto practical decisions in clinics.

The review also has limitations. It is a narrative rather than systematic review, so study selection may be incomplete and was not independently duplicated. Few studies isolated the specific contribution of community outpatient clinics, so some findings from centralised health department programmes have been extrapolated to the clinic setting. Much of the quantitative evidence comes from high-income countries, particularly the United States and United Kingdom, and may not transfer directly to lower-resource settings. Adherence data are largely self-reported and may overstate true adherence. Effectiveness estimates from modelling studies depend on assumptions about pre-symptomatic transmission and contact patterns that changed with new variants and vaccination. Finally, the supplementary health systems, operations and data governance sources were drawn from adjacent disciplines; they inform interpretation and recommendations but do not provide direct evidence on COVID-19 tracing outcomes.

Table 4. Suggested monitoring indicators for clinic-based tracing

Indicator	Definition	Suggested target
Testing timeliness	Median days from symptom onset to test	1 day or less
Reporting timeliness	Proportion of positive results reported to public health within 24 hours	90% or more
Interview coverage	Proportion of positive cases interviewed at the clinic or within 24 hours	80% or more
Contact disclosure	Proportion of interviewed cases naming at least one contact	Monitor trend; investigate falls
Contact reach	Proportion of named contacts notified within 48 hours of the index test	80% or more
Isolation support	Proportion of cases screened for support needs and referred where needed	100% screened
Adherence	Self-reported full isolation at a follow-up call	Monitor trend
Clinical monitoring	Proportion of high-risk isolated patients with a follow-up contact within 48 hours	90% or more

Targets are indicative and derived from modelled thresholds and guidance (European Centre for Disease Prevention and Control, 2020; Juneau et al., 2020; Kretzschmar et al., 2020); local teams should adapt them to capacity and epidemic phase.

4. CONCLUSION

Contact tracing and isolation can substantially reduce COVID-19 transmission, but only when they are fast, nearly complete and backed by support that makes isolation possible. During COVID-19, programmes commonly fell short on all three. Community outpatient clinics are positioned at the points where the cascade was weakest: testing delay, case interview, contact disclosure, isolation counselling and clinical monitoring. With clear roles, connected and secure data systems, reliable diagnostic and supply capacity, trained and protected staff, and guaranteed isolation support, clinics can turn contact tracing from a well-intentioned effort into

an effective public health intervention, both for the remaining phases of COVID-19 and for future respiratory pandemics.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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How to cite this article?

Olori U, Chukuigwe O, Ohunyon G, Kolawole OA (2022). Contact Tracing and Isolation Adherence in Community Outpatient Clinics During COVID-19: Effectiveness and Implementation Barriers. *Journal of Conventional Knowledge and Holistic Health*, 6(2)
