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ORIGINAL ARTICLE

Genomic multidisciplinary teams: A model for navigating genetic mainstreaming and precision medicine

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Aim: Recent rapid advances in genomics are revolutionising patient diagnosis and management of genetic conditions. However, this has led to many challenges in service provision, education and upskilling requirements for non-genetics health-care professionals and remuneration for genomic testing. In Australia, Medicare funding with a Paediatric genomic testing item for patients with intellectual disability or syndromic features has attempted to address this latter issue. The Sydney Children's Hospitals Network – Westmead (SCHN-W) Clinical Genetics Department established Paediatric and Neurology genomic multidisciplinary team (MDT) meetings to address the Medicare-specified requirement for discussion with clinical genetics, and increasing genomic testing advice requests.

Methods: This SCHN-W genomic MDT was evaluated with two implementation science frameworks – the RE-AIM (Reach, Effectiveness, Adoption, Implementation, Maintenance) and GMIR – Genomic Medicine Integrative Research frameworks. Data from June 2020 to July 2022 were synthesised and evaluated, as well as process mapping of the MDT service.

Results: A total of 205 patients were discussed in 34 MDT meetings, facilitating 148 genomic tests, of which 73 were Medicare eligible. This was equivalent to 26% of SCHN-W genetics outpatient activity, and 13% of all Medicare-funded paediatric genomic testing in NSW. 39% of patients received a genetic diagnosis.

Conclusion: The genomic MDT facilitated increased genomic testing at a tertiary paediatric centre and is an effective model for mainstreaming and facilitating precision medicine. However, significant implementation issues were identified including cost and sustainability, as well as the high level of resourcing that will be required to scale up this approach to other areas of medicine.

Key words: genomics; implementation science; precision medicine.

What is already known on this topic

1 Medicare funding for genomic testing in paediatrics commenced in 2020 for patients who meet certain criteria for intellectual disability and multiple congenital abnormalities for children less than 10.
2 This testing can be requested by paediatricians throughout Australia, only when performed 'in consultation with clinical genetics'.
3 While this is welcome funding for much needed genomic testing, there is a need for rapid upskilling and education in genomics for paediatricians, and improved facilitation of testing via existing clinical genetics services.

What this paper adds

1 The genomic multidisciplinary team improves collaboration between subspecialists and genetics services, to facilitate genomic testing and genomic 'mainstreaming'.
2 This approach provides an effective and efficient alternative to lengthening clinical genetics services waitlists and conventional models of outpatient referrals.
3 More evidence is required on the sustainability, cost-effectiveness and scalability of such a multidisciplinary model.

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The last decade has seen the continued expansion of the genomics 'revolution', bringing enormous opportunities and challenges to health-care systems and policy.[1] In Australia, this has led to massive increased demand for genomics expertise, as a genetic diagnosis has become the standard of care guiding management and access to clinical trials and therapies.[2] Rapidly falling genomic testing costs, combined with timely Medicare funding items for the 'mainstreaming' of genomics, have led to test requests being performed increasingly by non-genetics specialists and primary care. For example, since May 2020, under Medicare Benefits Schedule

item 73 358, paediatricians can now request genomic sequencing for patients who meet specific criteria for intellectual disability or a childhood syndrome after consultation with a clinical geneticist.

There remain significant challenges in the implementation of genomics in an equitable, cost effective and sustainable manner for maximum patient benefit.[1] This includes the barrier of adequate genomic education and capabilities amongst non-genetics professionals, and insufficient expert clinical genomics workforce.[2] The demand for genetics input into diagnostics is increasing rapidly with the advent of preconception population carrier screening, non-invasive and invasive prenatal genomic testing, cancer genetic testing and Medicare items in additional key areas of medicine beyond paediatrics (cardiac/cancer/renal/hearing loss/mitochondrial disease). Demand will grow due to complex downstream issues such as diagnostic genomic interpretation, patient management and gene therapy options, including clinical trials.

In Australia, precision medicine – tailoring an individual's management and health to their genetic information – borders on a reality.[3] However, it has also led to a considerable burden on limited resources in genetics services,[4] with a doubling of waitlists for clinical genetics appointments in NSW.[5] At Sydney Children's Hospitals Network – Westmead (SCHN-W) – the paediatric genetics service attends to over 1000 children and their families with genetic conditions annually as a major tertiary paediatric centre servicing Western Sydney and rural New South Wales.

To address this massive increased demand for genomics input, multidisciplinary team (MDT) meetings were introduced in 2020 at SCHN-W. The Paediatric MDT was established as 'consultation with clinical genetics' was a pre-requisite for Medicare-funded paediatric genomic testing. A similar MDT approach was undertaken in neurology, due to many referrals for complex patients requiring genomic testing for diagnosis and management. These MDTs include the presence of medical subspecialists, clinical geneticists, genetic counsellors, genetic pathology and molecular scientist expertise, and are used in various forms in other areas including oncology, hearing loss, maternal fetal medicine and ocular genomics at SCHN-W.

Some studies have highlighted the benefits of such an interdisciplinary approach, to improve collaboration for complex patient scenarios/results in genomics, as well as improving education, outreach and mainstreaming of genomics.[6,7] However, there are few existing MDT and genomic services that harness the implementation of science-based approaches to studying the multi-level and complex issues inherent in health system interventions.[8] Frameworks such as RE-AIM, take into account the internal and external factors for evidence-based practice uptake to evaluate the Reach, Effectiveness, Adoption, Implementation and Maintenance of a programme.[9] The RE-AIM framework has been used to plan and evaluate population genomic screening programs and other health system interventions over the last two decades including precision health care.[10,11]

The aim of this study was first to evaluate the genomic MDT model and its impact on improving genomic diagnostic testing mainstreaming at SCHN-W. Second, we aimed to study genomic MDT implementation components and outcomes, such as reach, adoption and sustainability, in order to provide a process model that can be adapted for other centres and health systems beyond paediatrics.

Methods

In this quantitative study, we gathered data from all patients discussed from the first 2 years (June 2020 to July 2022) of Paediatric and Neurology genomic MDT meetings. Quantitative data were collected on a REDCap database and synthesised using descriptive statistics (age, clinical details, clinical question and referral source) and qualitatively (MDT discussion minutes and notes, documentation from electronic medical records). Further synthesis was performed in the context of the RE-AIM framework addressing the Reach, Effectiveness, Adoption, Implementation and Maintenance of the MDT (Supporting Information: Table 1).

We also used process mapping with the SCHN-W department team, mapping the patient pathway to document their journey through the MDT. This was verified within our department of eight clinical geneticists and five genetic counsellors for accuracy. Further evaluation of the MDT with particular focus on genomic implementation factors was performed with the Genomic Medicine Integrative Research (GMIR) framework,[12] to address the questions of scalability and sustainability of the MDT process (Supporting Information: Table 1).

Results

A total of 223 patient discussions involving 205 unique patients occurred over 34 MDT meetings between June 2020 and July 2022 (Fig. 1, Table 1). In the same time period, compared to 205 patients discussed in both MDTs, 785 patients were seen concurrently in the SCHN-W paediatric genetics clinics, which is where the MDT patients would have been seen if they were referred via our conventional referral pathways (Fig. 2). This means the MDT facilitated genomic care for about one quarter (26%) – of the equivalent outpatient clinical activity during this period. Overall, the genomic MDT facilitated 73 Medicare eligible paediatrician-requested genomic tests, which is 13% of the tests requested across NSW in this period[13] [http://medicarestatistics.humanservices.gov.au/]. Overall 124 genomic tests were facilitated through the MDT, of which 39% of cases were diagnosed.

Reach

The Neurology genomic MDT discussed 192 (86%) cases, whereas the Paediatric MDT discussed 31 (14% of total MDT) cases (Table 1). In the Paediatric MDT, the majority of patients had autism (65%), global developmental delay (45%) or intellectual disability (42%). Many of the Neurology MDT patients had complex and mixed multisystem disorders: with seizures (28%), autism (23%), hypotonia (18%), global developmental delay (38%) and intellectual disability (24%) (Supporting Information: Fig. 1).

Referrals to the Paediatric MDT were mainly from local sources, but a significant proportion (22.5%) were from rural paediatricians (Supporting Information: Fig. 1). Private referrals comprised 10% of Neurology referrals, and 6.5% of general Paediatric referrals.

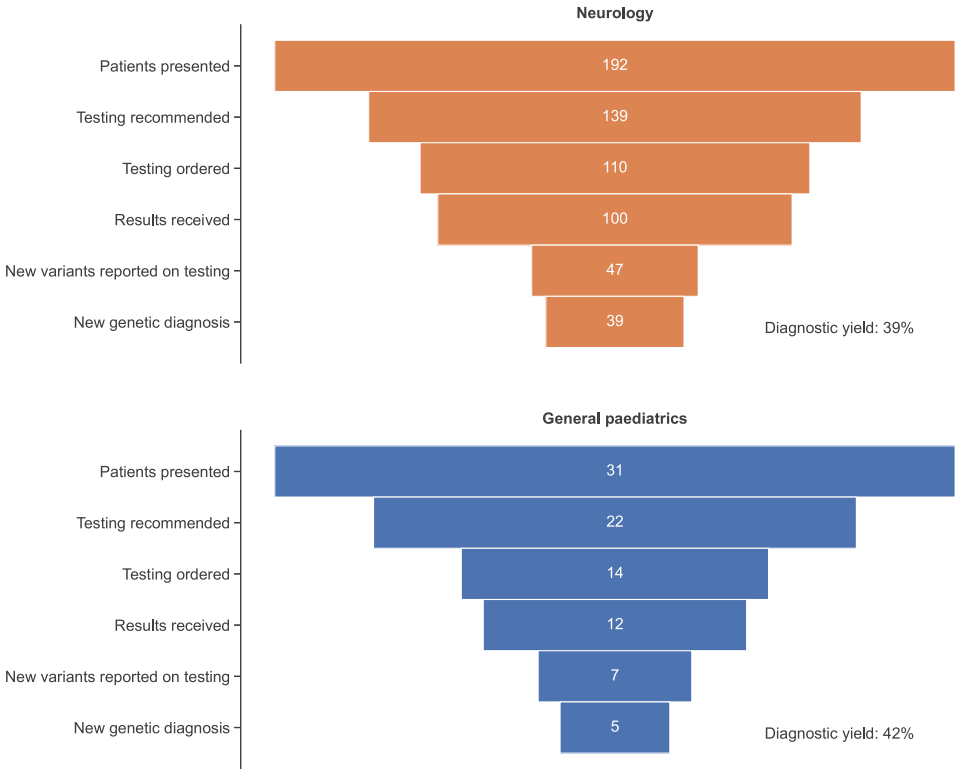

Fig. 1 Effectiveness of the genomic MDT to facilitate advice and testing for genomic diagnosis. This figure demonstrates the number of patients presented, recommendations and outcomes of the Neurology and Paediatric MDTs, including diagnostic yield. MDT, multidisciplinary team.

Effectiveness

Of the 31 cases discussed in the Paediatrics MDT, 29 were presented to discuss eligibility for Medicare-rebatable genomic testing (Table 1, Fig. 1). Of these, 23 were recommended to undergo further genomic testing, and 22 (96%) were eligible for Medicare rebated testing (Table 1). To date, 14/23 (61%) have had genomic testing performed and 12/14 results are available, revealing 5 (42%) with a pathogenic variant in a gene responsible for the patient's condition. Two cases were identified with variants of uncertain significance as per ACMG guidelines.[14]

In Neurology, of the 192 cases discussed, 187 were presented to discuss choice of appropriate genomic testing and to fulfil the Medicare-required criteria of discussion with a clinical geneticist prior to test requests. Of these, 139 (74%) were recommended to undergo further genomic testing, of which 110 (79%) have undergone testing so far. 100/110 results are available, and 39 (39%) have a pathogenic variant leading to a genetic diagnosis. Six cases were identified with variants of uncertain significance.

Adoption

The Paediatric MDTs were received from a mix of referrals from 17 clinicians, including 2 rural/regional Paediatricians, 2 SCHN-W developmental, 5 local general Paediatricians (33% of the entire department) and 2 private Paediatricians (Table 1). Attendance included 14 on average, with a mix of clinical genetics, genetic counsellors, trainees and paediatricians (Supporting Information: Fig. 2).

In Neurology, all 192 cases were referred by a total of 17 clinicians including 15 neurologists (100% of the SCHN-W neurology department), 1 metabolic physician and 1 geneticist. The mean number of attendees was 16 (Supporting Information: Fig. 2).

Implementation

Process mapping showed that the MDT was an alternative pathway for selected patients to genetics referrals, with three distinct phases (Fig. 2). Pre-MDT patients were referred, clinical and genetic data were gathered and decisions within the department were made about eligibility for MDT discussion. The MDT meeting usually involved sub-speciality collaboration and discussion, including with the laboratory, and collaborative decision-making between clinical genetics, the laboratory, and the referring specialist, to reach a consensus decision which was documented for follow-up by the relevant health-care provider. Recommendations made post-MDT meeting included genomic testing, interpretation of results as per ACMG guidelines[14] and management for the patient (Fig. 2).

Further mapping into GMIR framework helped identify the implementation processes and interventions involved in each MDT (Table 1). The Paediatric MDT process focused on patient genomic testing eligibility in light of Medicare-funded testing by Paediatricians. The Neurology MDT also focused on the question

Table 1 RE-AIM evaluation of the Paediatric and Neurology genomic MDT

	Paediatric MDT	Neurology MDT
Reach	31 cases discussed over 11 meetings (29 unique patients)	192 cases discussed over 23 meetings (176 unique patients)
Effectiveness	29/31 cases were presented to discuss Medicare eligibility/genomic testing, and 22 met Medicare eligibility. 22/29 cases had genomic testing recommended 14/23 cases had testing ordered, all of which were Medicare eligible 12/14 have results available 5 uninformative 2 variants of uncertain significance 5 pathogenic variants leading to new diagnosis (42% yield)	187/192 cases were presented to discuss choice of most appropriate genomic test. 139/187 cases had genomic testing recommended 110/139 cases had genomic testing ordered, including 59 Medicare eligible genomic tests 100/110 have results available 53 uninformative 6 variants of uncertain significance 2 incidental findings 39 pathogenic variants found, leading to a new diagnosis (39%)
Adoption	17 clinicians referred, comprised of: • 5 local Paediatricians (33% of SCHN-W paediatric department) • 5 rural Paediatricians • 2 private Paediatricians • 2 developmental Paediatricians • 2 clinical geneticists • 1 respiratory Paediatrician	17 clinicians referred, comprised of: • 15 neurologists (100% of SCHN-W neurology department) • 1 metabolic physician • 1 clinical geneticist
Implementation	*Key Q: Is my patient eligible for a Medicare funded test?*	*Key Q: What test should I perform for a diagnosis?*
Context	29/31 cases for Medicare eligibility discussions, with an additional 4 results discussions including 1 VUS.	Discussion of genomic testing options for complex Neurology patients.
Interventions	Virtual PowerPoint/Teams presentation of patient, discussed how they met Medicare eligibility with genetics consultation/input. Education on the process of genomic test ordering including consent, sample requirements and paperwork required for ordering testing and offering genetics support for Paediatricians.	Many discussions regarded the optimal testing option given the prior testing (sometimes including research) for the patient, the complex phenotype, and yield, and rapidly changing environment of testing and reimbursement for testing (single gene vs. panel vs. exome vs. genome vs. research) over time.
Processes	Advice provided and documented on Teams and EMR, Genetics facilitation of testing offered and minutes sent to Paediatrician.	Advice given and almost all seen, consented, and tested by the neurologists.
Outcomes	13/14 (93%) of tests ordered required genetics assistance. While 22 cases were Medicare eligible, 8 were not ordered, mostly due to being lost to follow-up.	Almost all cases tested by neurologists – only 2/110 had additional genetic assistance. 29/139 cases recommended for genomic testing had not yet had tests ordered.
Maintenance	Meetings 2 monthly, reviewing 3 cases per meeting.	Monthly meetings, 8 cases per meeting discussed.

This table summarises the RE-AIM and GMIR implementation framework evaluation of the MDTs in Paediatrics and Neurology. EMR, electronic medical record; GMIR, Genomic Medicine Integrative Research; MDT, multidisciplinary team; RE-AIM, Reach, Effectiveness, Adoption, Implementation and Maintenance; SCHN-W, Sydney Children's Hospitals Network –Westmead; VUS, Variant of Uncertain Significance.

of which genomic test was optimal given the complex presentation of patients requiring a genetic diagnosis.

We identified some gaps in processes in the post-MDT outcomes. In the Paediatric genomic MDT, 64% of the testing was primarily arranged by the referring Paediatrician, with the remainder facilitated by the clinical genetics service. However, 13/14 patients (93%) of the overall testing required some genetics assistance, including help with requesting testing, primarily to help with patient consent and laboratory paperwork, reminder emails, and, in some instances, genetic referrals. Of the 23 recommendations for genomic testing, 8 (35%) have yet to be requested, with most patients being lost to further paediatric

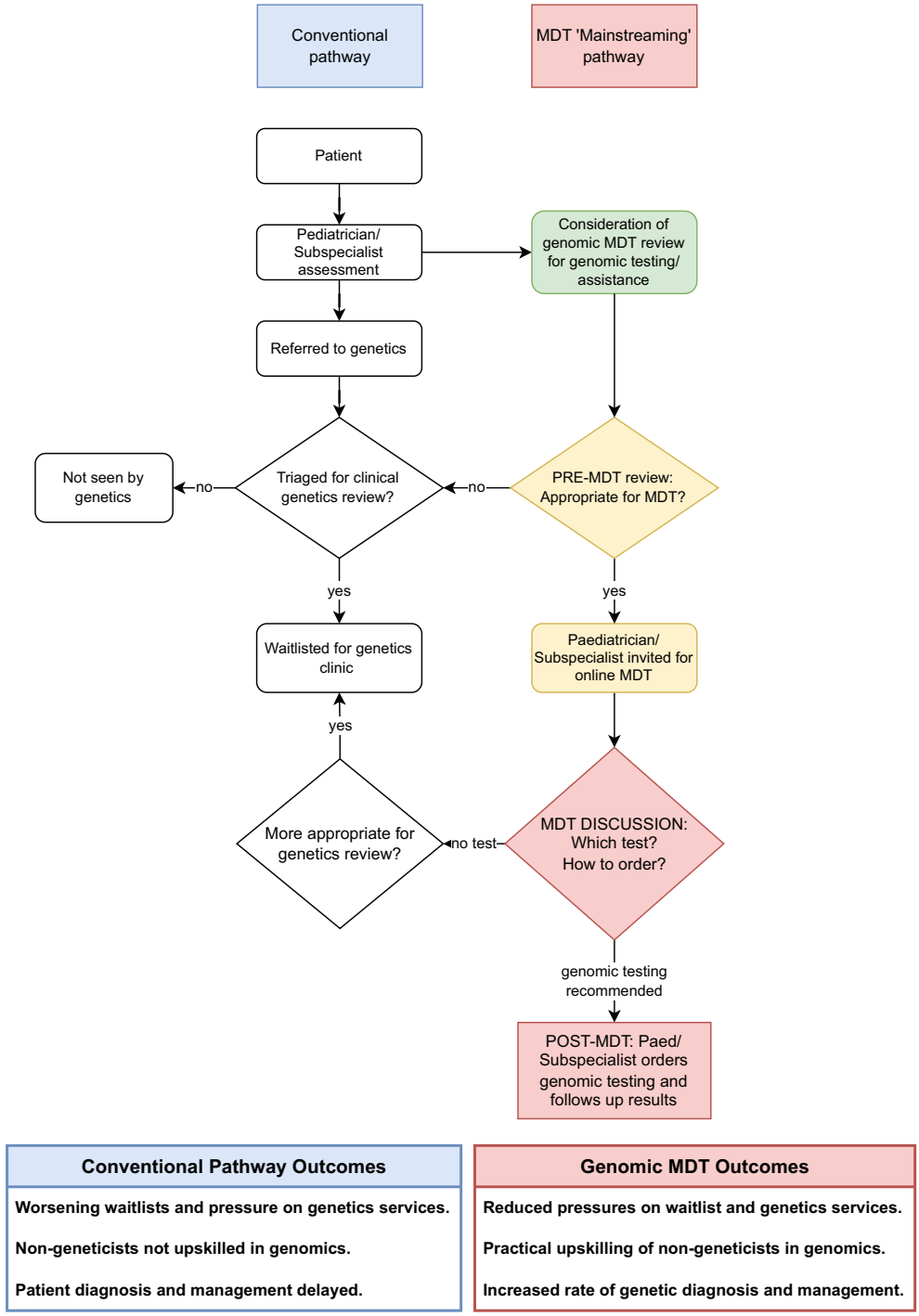

Fig. 2 The genomic MDT is an alternative to conventional genetics referrals, and provides a pathway to mainstreaming. The implementation process mapping of our MDT pathway demonstrates the conventional 'standard' referral pathway as well as the pre-MDT, MDT and post-MDT steps of the mainstreaming pathway and outcomes. MDT, multidisciplinary team.

follow-up. In the Neurology MDT, most of the testing (87%) was requested by the speciality clinician. Out of the 139 recommendations for further genomic testing, 29 (21%) had not been requested at the time of publication.

Maintenance

The RE-AIM framework typically refers to 'maintenance' as how an innovation has been sustained beyond the initial 12 months

after implementation. As the study period extended only to the first year of implementation, we can report only limited data about short-term issues that arose. This was mainly around reorganisation of the SCHN-W clinical genetics service that was required to readjust resourcing for the establishment of multiple genomic MDTs, which indirectly impacted exacerbating the demand on existing clinical services waitlists and staffing.

Discussion

As the largest paediatric genomics service in NSW, we have demonstrated the SCHN-W genomics MDT model is able to reach a large number of patients and clinicians and engage them in a genomics model of care that facilitates the uptake of genomic testing through 'mainstreaming' and upskilling of health-care providers, particularly in light of recent Medicare funded Paediatric genomic testing. The SCHN-W genomic MDT has facilitated 13% of Medicare-funded genomic testing in NSW, and represents a corresponding 26% of outpatient activity of our genetics department. The 39% overall diagnostic yield is entirely consistent with the literature on genomic testing in Paediatrics,[15] and the MDT approach demonstrates the importance of interdisciplinary collaboration to address the complexity of eligibility assessment and choice of appropriate genomic testing in a tertiary setting.

A genomics MDT model facilitates testing and enables mainstreaming and precision medicine

Our MDT model enables genomics uptake, alleviates the burden of increasing waitlists, and helps to improve the dissemination of genetic knowledge.[16,17] A recent report on actual versus expected uptake of Medicare-funded genomic testing in paediatrics has shown a significant (almost threefold) reduced uptake in Australia, with considerable geographical variation between states.[18] Possible causes included the clinical genetics workforce crisis,[19,20] and lack of MDT support for paediatricians. Also, different funding arrangements exist in each state, which means that some state-based public hospital services are already paying for testing, and therefore cannot access the federally funded Medicare item. In these states, only private paediatricians can utilise this Medicare-funded testing, and therefore the same MDT approach may not be beneficial. Much literature has identified that many non-genetics health-care professionals are concerned about a lack of genetics knowledge, and confidence in discussing genetics, and about the relevance of genetics in their practice.[17]

Furthermore, enablers of genomics have been identified, such as collaborative relationships between clinicians and genetics professionals, to improve education, enable appropriate referrals, and open avenues for discussing genetics issues. This has been correlated with recent interviews of Australian clinicians highlighting that service models such as MDTs can enable mastery of genomics and foster independence for genetic test requesting, providing support for genetics 'backup' without the need for waitlisting on genetics clinics.[21]

We have shown here that the MDT, with a focus on facilitation of testing uptake, facilitates mainstreaming, by providing an avenue (outside of traditional referral/clinical services) where they can act in a supported and facilitated manner, to upskill and adopt genomics into their practice (Fig. 2). This may be an important model for other states and services trying to meet increased demand for genomics advice and input for precision medicine. However, it must be recognised that significant post-MDT support from the genetic counselling team is required, and there is a limit to the extent of additional services such an approach can provide in the long term.

Limitations and areas for further study

While we had good engagement with developmental and rural paediatrics services, these services struggled both to present patients and to follow up on recommendations for testing. This is complicated by the fact that SCHN-W provided the main COVID-19 Paediatric care for NSW throughout the pandemic, and many Paediatricians were contributing to this service. However, there was a heavy dependence on the genetic counsellors to help facilitate testing, paperwork and follow-up in 93% of patients, rather than by the Paediatricians alone as intended. Increasingly, the key role of genetic counsellors in facilitating genomic mainstreaming/upskilling, and family care in the genomic era is being recognised, and this is reflected in our study.[22–24]

The Neurology MDTs discussed a large number of patients, engaged all the members of the Neurology department, and had a high yield of testing. However, in both MDTs, a large proportion of patients were either not tested, or recommendations for testing were not followed. A limitation of our study was insufficient data to understand the reason for this. This lack of uptake for testing limits the efficiency of the MDT and warrants further investigation.

Importantly, the additional 205 patients discussed (equivalent to 26% of patient activity at SCHN-W) in the genomic MDT require adequate ongoing resourcing to enable sustainability. This has had an impact on the service provision from our unit, including the significant genetic counsellor input required for 'mainstreaming' as well as reduction in clinical services due to increased demand for clinical genetics input into multiple MDTs. While efficiencies may be generated by enabling mainstreaming, these may not meet the excess demand for genomics services, particularly as increased testing leads to demand for results interpretation (especially variants of uncertain significance), and new clinical trials and therapies emerge alongside new Medicare-funded genomic tests (e.g. hearing loss, mitochondrial diseases, cardiac, renal, carrier screening and cancer).

Further study with a qualitative and implementation approach is needed to assess the adoption of genomics and scalability of the MDT model to promote mainstreaming in additional areas of medicine. However, these findings are consistent with a recent systematic review highlighting the power of the genomic MDT for effectiveness, efficiency, and promoting mainstreaming and collaboration.[25] Additionally, an evaluation of the cost-effectiveness, sustainability, and feasibility of such a service is needed before further practice and policy can align with the implementation of such an approach.

Conclusion

The Paediatric genomic MDT has led to a considerable uptake of Medicare-funded genomic testing in NSW. It provides an avenue for exploring genomic patient and testing queries, facilitating mainstreaming and education about genetic testing, and interdisciplinary collaboration. While further evidence is needed about the impact on practice, feasibility and sustainability, it provides a

new model of care that could promote precision medicine in more areas of the health system, including adult medicine, especially as new Medicare items and funding for genomics and mainstreaming increase.

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Ethics statement

This study has Human Ethics Research Committee approval under Sydney Children's Hospitals Network Ethics (protocol no. 2021/ETH12224).

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Data S1 Suppl Table 1. RE-AIM framework definitions for the genomic MDT.
Suppl Fig. 1. Referral source and phenotypes of patients in the MDTs.
Suppl Fig. 2. Average attendance for the Neurology and Paediatric MDTs.