Keep within sight and reach: teaching paediatric prescribing

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Although knowledge of paediatric prescribing is particularly important for medical students, most undergraduate medical training is spent in adult settings. In this article, two medical students provide their perspectives on the teaching of paediatric prescribing in an undergraduate curriculum and provide suggestions for how this could be improved.

![Diagram](Figure 1. Causes of prescribing errors specific to paediatrics. These core differences between prescribing in children and adults ultimately lead to children being disproportionately affected by prescribing errors. Figure adapted (with permission) from Conn et al, BMJ Open 2019)

Safe, appropriate, effective and economic drug prescribing is one of the GMC’s overarching Outcomes for Graduates. Regardless of grade, all doctors make prescribing errors, but newly qualified doctors have the highest rate. Although many factors contribute to prescribing errors, recent research suggests that medical students believe undergraduate training does not sufficiently prepare them for prescribing.

There are further reasons why paediatric prescribing is particularly important for medical students, including a specific duty to “recognise the challenges of safe prescribing... at extremes of age” in Outcomes for Graduates. Following qualification, they will meet and treat children across all specialties – paediatric prescribing is not carried out only by paediatricians. Hence, if the aim of undergraduate training is to produce good and safe doctors, medical students must be prepared and equipped to undertake paediatric prescribing. Additionally, knowledge of paediatric prescribing will
serve medical students well in examinations. As well as questions in internally set university examinations, the Prescribing Safety Assessment (PSA; a national examination sat by all final-year UK medical students allowing proof of competent and safe use of medicines) contains four questions on paediatrics within its blueprint.

As most undergraduate training is spent in adult settings, medical school curricula tend to focus on teaching prescribing in adult populations. Some of the skills taught are transferable to a paediatric population. However, the process of prescribing in children differs from adults in many aspects. A scoping review found fundamental differences in paediatric prescribing that can lead to prescribing errors, as shown in Figure 1. Underlying these fundamental differences are multiple biopsychosocial characteristics of children, described in Table 1, which taken together mean prescribers need specific experience of working with children. Alongside these paediatric-specific challenges are factors that impact prescribing more generally, such as busy workplaces, insufficient training and poor communication. For these reasons, children are often disproportionately affected by drug errors, making adequate teaching even more important.

The curriculum at Bristol Medical School covers most paediatric learning outcomes in a six-week paediatric clerkship in year 4 of 5. This article will reflect on our experiences as two medical students undertaking the clerkship and will provide our perspectives on the teaching of paediatric prescribing in an undergraduate curriculum. Through this, it will aim to provide suggestions from students for those designing and developing paediatric prescribing teaching sessions and curricula (see Key points box).

**A dedicated teaching session**

Due to timetabling differences, we (the authors) completed our clerkships at different points in the year. There was variation in teaching received by each because the curriculum underwent in-year innovation with each iteration of the clerkship. In our view as medical students, the most significant change was the introduction of a 75-minute seminar on paediatric prescribing delivered on day 1 of the clerkship. It was introduced in response to student feedback and was therefore offered during the clerkship later in the academic year, but not at the start. It was delivered by a paediatric clinical teaching fellow (a qualified doctor working a mixed-contract with clinical and teaching commitments) and was mandatory for all students undertaking the clerkship. The seminar used a mixture of both didactic lecturing and interactive tutorials and was delivered to eight students at a time. It covered three main learning points: the differences between adult and paediatric prescribing, fluid prescribing in children, and hands-on practice of prescribing on mock drug charts.

Differences between adult and paediatric prescribing were generated using a brainstorming session, followed by didactic teaching covering the differences mentioned earlier in this article, as well as the importance of weight-based dosing, formulation choice and monitoring. The second learning point, fluid prescribing, is a known weakness of recently qualified doctors. The seminar covered basic physiology and risks of fluid prescription followed by teaching on three fluid prescriptions: fluid resuscitation, maintenance fluids, and management of dehydration. These regimens included specific recommended prescriptions and volumes based on the *British National Formulary for Children (BNFc)* fluid requirements and local hospital policy. Finally, hands-on practice with case examples gave the opportunity to use university mock drug charts and the BNFc to perform drug and fluid calculations and physically write prescriptions for simulated paediatric patients.

As medical students, we believe that completion of the seminar on day 1 not only improved our overall ability and confidence in paediatric prescribing, but also allowed students to better engage with the full clerkship. Having underlying knowledge of the prescribing decision-making process improved our understanding of, and input into, ward prescribing being carried out by paediatricians.

| Biological                          | Psychological                                    | Sociological                          |
|------------------------------------|-------------------------------------------------|---------------------------------------|
| • Rapid growth in children results in highly variable size and weight requiring more complex drug calculations | • Variable cognition and levels of capacity | • Difficulty swallowing medications |
| • Variable pharmacokinetics and pharmacodynamics because of differences in liver metabolism, renal excretion, and fat distribution | • Variable understanding of disease and intended therapeutic effects of medications | • Preferred use of formulations that are uncommon in adult prescribing such as liquid suspensions |
| • Increased surface area: volume ratio with increased fluid losses | • Variable ability and desire to engage in shared decision making | • Reliance on carers for concordance, adherence and administration |
| • Development and maturation (including puberty) | • Limited evidence base with exclusion of children in research and resultant increase in off-licence prescribing | • Differing disease states depending on age |
| • Differing disease states depending on age | • Increased risk of unsafe medication use, requiring risk management strategies such as childproof containers and storage ‘out of sight and reach’ | • Prematurity |

Table 1. The biopsychosocial characteristics of children that make paediatric prescribing challenging and require prescribers to have experience of working with children. These ultimately underly the fundamental differences that lead to prescribing errors (outlined in Figure 1).
EDUCATION | Paediatric prescribing

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The importance of teaching prescribing skills to medical students is reflected in GMC recommendations and the existence of the national Prescribing Safety Assessment. But paediatric prescribing presents specific challenges, clearly articulated by the authors of this article.

The observations and suggestions made here reflect the learning experiences of the authors as medical students at my own institution, and of course may not generalise. Good (and indeed less good) teaching experiences are often very dependent on the educator delivering them. Evidence of ‘effectiveness’ is lacking. Some recommendations – for example, effective feedback mechanisms – are obviously not confined to one area of the curriculum and extend beyond prescribing.

As the person with responsibility for the teaching of prescribing in Bristol, I welcome the idea of sessions dedicated specifically to paediatric prescribing skills, including practical exercises and how to approach shared decision making. But I also accept that there are competing priorities, and that increased prescribing teaching cannot come at the expense of other fundamental aspects of medicine.

I’d encourage clinical teachers to give due consideration to the points made by the authors. But for those already struggling to deliver an already crammed curriculum, perhaps don’t think of paediatric prescribing as a separate learning objective. Rather, as a valuable opportunity to revisit key generic issues – such as effective communication, accurate dosing, appraisal of limited evidence – relevant to all age groups and to good clinical practice more generally, prescribing related or otherwise.

Practising the practical procedure

Many different methods can be utilised to teach prescribing skills. While larger group lectures are useful to teach valuable overviews on topics, they often lack the opportunity to practise applying the theory. A new curriculum at the University of Bristol was introduced in 2017, which uses a small group case-based learning (CBL) approach to teaching. A new case is discussed every week with pre-set questions to answer and scope to research the most important aspects in detail. CBL enables students to incorporate pre-taught theory as well as practise clinical skills such as prescribing within a given clinical context.

During both authors’ paediatric clerkship, CBL sessions were not used as an opportunity to discuss the nuances of paediatric prescribing or practise physically writing prescriptions. At the other extreme of age, during an elderly care clerkship, there was significant time and emphasis given to teaching and practising prescribing. Multiple elderly care CBL sessions asked students to prescribe or edit university mock drug charts while considering polypharmacy, medication side-effects, altered pharmacokinetics and pharmacodynamics, and co-morbidities such as renal impairment. These mock prescriptions were then reviewed by clinical teaching fellows who provided immediate constructive feedback, which has been shown to have a significant impact on medical student learning and development. This ultimately improved students’ confidence with adult prescribing.

CBL was perhaps a missed opportunity to cover additional considerations when prescribing in paediatrics, in particular accounting for the age and weight of the child, deciding whether alternative formulations are required, and off-licence prescribing. It should be noted that the elderly care clerkship ran for 18 weeks and hence was less time-constrained than the paediatric clerkship, perhaps allowing for more focus on the teaching of prescribing. Regardless, we suggest offering as many opportunities to physically practise prescribing as time allows, with opportunities for immediate feedback from suitably qualified teachers.

Prescribing in general practice

In year 4 at Bristol, medical students undertake a year-long general practice clerkship, attending placements in primary care once weekly. Students are encouraged to run their own clinics and develop management plans under the supervision of a teaching GP. This experience allows ad hoc learning opportunities on managing paediatric conditions in primary care, including prescribing considerations. Many common consultations present these opportunities, such as altering asthma medication, advising on over-the-counter medications, and making decisions on whether or not to issue antibiotics. However, there is often a disparity between students in the number of such opportunities, as it is dependent on how many paediatric patients are booked in throughout the clerkship. More formalised teaching programmes might help
ensure more students get exposure to paediatric prescribing in primary care. We received no formal teaching on paediatric prescribing in the primary care clerkship, despite having tutorials covering common paediatric conditions. Similarly to CBL, we believe these tutorials provide an opportunity to physically practise prescribing based on age and weight with the necessary drug calculations and use of the BNFc. Additionally, tutorials could be used to further discuss considerations and off-licence prescribing (and to practise how these can be explained to patients and parents, either real or simulated). This also offers a valuable opportunity to practise writing an FP10 prescription and using electronic prescribing (ePrescribing) to complement learning using a hospital drug chart when based in secondary care on placement. Depending on timing (and how primary care placements fall in relation to paediatric placements), an introductory teaching session on the differences between adult and paediatric prescribing could be useful, as recommended previously. This could focus on common paediatric prescribing decisions in primary care, taking advantage of supervising GPs’ experience and knowledge. Primary care placements offer a potential time to cover paediatric prescribing outside paediatric clerkships.

ePrescribing systems have proven benefits such as improved legibility, accountability and alerts on dose, interactions and contraindications.\(^\text{19,20}\) As ePrescribing is widely used, adequate medical student exposure is important, but understandably there are restrictions on adding and issuing medications. In our experience, this means prescribing in primary care is often done by the supervising GP without student involvement. While this saves time, it removes opportunities to discuss considerations and choices while prescribing and for students to familiarise themselves with ePrescribing systems and the BNFc. Naturally, the extent of this varies between supervising GPs and practices. There will be occasions when time constraints do not allow this, but we suggest that those developing paediatric prescribing curricula aim to allow medical students to use ePrescribing during consultations as much as possible.

**Calculations and formularies**

Drug calculations and prescribing are intrinsically linked. Both the GMC and the Medical Schools Council Safe Prescribing Working Group expect newly qualified doctors in the UK to have “the ability to calculate appropriate doses” on completion of medical school.\(^\text{1,21}\) Yet anecdotally, drug calculations are one of the most feared aspects of medical school curricula, with many students lacking confidence.

As previously discussed, paediatric prescribing is where we as students see the greatest number of drug calculations in clinical placement. Consequently, it was also where we saw the most use of the BNFc, with clinicians using it constantly rather than relying on memorised dosages. Seeing the use of both calculations and formularies in practice emphasised their importance, and we therefore suggest that paediatric clinical placements are an opportunity to focus student teaching and learning on drug calculations and the use of formularies. Research from Nigeria showed that less than 50% of medical students could correctly calculate correct dosages of four common drugs following completion of their paediatric attachment.\(^\text{22}\) The generalisability of this study should be questioned; however, we believe the opportunity to focus teaching on drug calculations still exists.

Within our clerkship, there was no additional support or teaching time covering drug calculations or the use of formularies. Any formalised teaching offered needs to be carefully balanced – some students are more confident in these skills and within a busy curriculum they may not be the most efficient topics to cover. Additionally, the PSA (which tests drug calculations and use of the BNFc) pass rate sits at around 95%.\(^\text{23,24}\) suggesting these skills may be achieved by students by the time of graduation, although breakdown of score by blueprint is not published, so it is difficult to determine whether calculations are performed...
Nonetheless, the paediatric prescribing curriculum is an ideal place to introduce formal teaching on drug calculations, which are critical to safe and effective prescribing not just in children but also in wider clinical practice.

**Shared decision making**

Throughout the Bristol Medical School curriculum and in the wider healthcare setting, there is an emphasis on the importance of shared decision making (SDM). SDM involves both healthcare professionals and patients using evidence-based medicine and a “person’s individual preferences, beliefs and values” to reach decisions on investigations and management.25

There are unique challenges in paediatric SDM,26,27 both generally and specifically with regard to prescribing. SDM can include the clinician and child as well as carers, this of course being dependent on the child’s capacity. SDM also carries the potential challenge of differing opinions between children and their carers. Furthermore, as previously discussed, there is increased off-license use of medication in children and communicating this effectively can be difficult. Consequently, the degree of involvement of children in SDM often changes as they age, mature and develop further understanding of their conditions and treatments,27 not least as their legal status changes with protections such as Gillick competency.28 It is important that clinicians can recognise the fluidity of this situation and when to involve children in SDM when prescribing. Clinicians are expected to have up-to-date, evidence-based knowledge with the ability and resources to share this with those involved in decision making, particularly ensuring accessibility for children, which can be time-consuming and challenging.

We could find no published evidence on how often SDM is taught in the context of paediatric prescribing in medical schools more generally. In our experience, there was virtually no teaching on how to approach SDM when prescribing in paediatrics or consideration of the added challenges. Despite this, newly qualified doctors working with children will have to navigate these situations. Paediatric SDM generally is an under-researched field,27 with even less literature focused on prescribing, so it is understandable that this is not covered in medical school curricula. Further research in this area may inform improved curriculum design.

**Conclusions**

Safe and effective paediatric prescribing is a vital skill for newly qualified doctors across varied specialties, and yet it presents unique challenges compared to adult prescribing. This article presents our views, as two medical students, on the teaching of prescribing following completion of a paediatric clinical placement. Drawing on our experiences, we present suggestions (see Key points box) for those designing paediatric curricula on how prescribing could be taught.

We have identified teaching practices that work well, including: an introductory seminar with an overview of paediatric prescribing; the ability to physically practise writing mock prescriptions; and utilising general practice teaching time to supplement paediatric-specific placements. We have also identified opportunities to further develop teaching practices, including increasing support for students with drug calculations during paediatric placements and improving the teaching of shared decision making in paediatric patient populations.

We as students enjoyed working in paediatrics immensely and found prescribing in this specialty interesting, but we found ourselves pushed and challenged by it at times. We hope this article provides a useful insight to assist the development of curricula to teach this, which in turn will result in better-prepared doctors at the point of qualification.

**References**

1. General Medical Council. Outcomes for graduates. Vol. 1. GMC Publications, 2018.
2. Dornan T, et al. An in depth investigation into causes of prescribing errors by foundation trainees in relation to their medical education: EQUIP study. General Medical Council, 2009.
3. Kennedy MB, et al. The role of undergraduate teaching, learning and a national prescribing safety assessment in preparation for practical prescribing: UK medical students’ perspective. Br J Clin Pharmacol 2019; 85(10):2390–8.
4. Maxwell SRJ, et al. Prescribing Safety Assessment 2016: Delivery of a national pre-
scribing assessment to 7343 UK final-year medical students. Br J Clin Pharmacol 2017; 83(10):2249–58.
5. British Pharmacological Society. Prescribing Safety Assessment – Blueprint. August 2021. Available from: https://prescribingssafetyassessment.ac.uk/resources/PSA-Blueprint.pdf
6. Conn RL, et al. What causes prescribing errors in children? Scoping review. BMJ Open 2019;9(8):e028680. This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license. See: https://creativecommons.org/licenses/by-nc/4.0/
7. Kaushal R, et al. Medication errors and adverse drug events in pediatric inpatients. J Am Med Assoc 2001;285(16):2114–20.
8. Ghaleb MA, et al. The incidence and nature of prescribing and medication administration errors in paediatric inpatients. Arch Dis Child 2010;95(2):113–8.
9. University Hospitals Bristol and Weston NHS Foundation Trust. Medical education. 2021. Available from: http://www.uhbristol.nhs.uk/work-for-us/education-learning-and-development/clinical/medical-education/
10. Powell AGMT, Paterson-Brown S. Safety through education: FY1 doctors still poor in prescribing intravenous fluids. BMJ 2011;342:d2741.
11. Paediatric Formulary Committee. BNF for children. London: BMJ Group, Pharmaceutical Press and RCPCH Publications, 2021. Available from: http://www.medicinescomplete.com
12. Jones R, et al. Changing face of medical curricula. Lancet 2001;357:699–703.
13. Kogan JR, Shea JA. Course evaluation in medical education. Teaching Teacher Educ 2007;23(3):251–64.
14. Hsh KW, et al. The Student Curriculum Review Team: how we catalyze curricular changes through a student-centered approach. Med Teach 2015;37(11):1008–12.
15. Nazar H, et al. Teaching safe prescribing to medical students: perspectives in the UK. Adv Med Educ Pract 2015;6:279–95.
16. Bristol Health Partners. Launch of Bristol Medical School marks new era for medical education. August 2017. Available from: https://www.bristolhealthpartners.org.uk/latest-news/2017/08/01/launch-of-bristol-medical-school-marks-new-era-for-medical-education/921
17. Srinivasan M, et al. Comparing problem-based learning with case-based learning: Effects of a major curricular shift at two institutions. Acad Med 2007;82(1):74–82.
18. Murdoch-Eaton D, Sargeant J. Maturational differences in undergraduate medical students’ perceptions about feedback. Med Educ 2012;46(7):711–21.
19. Went K, et al. Reducing prescribing errors: can a well-designed electronic system help? J Eval Clin Pract 2010;16(3):556–9.
20. Craxford S, et al. The learning curve of electronic prescribing. Br J Hosp Med 2015;76(9):538–40.
21. Medical Schools Council. Outcomes of the Medical Schools Council Safe Prescribing Working Group. Background to the working group. November 2007. Available from: https://www.medschools.ac.uk/media/1892/outcomes-of-the-medical-schools-council-safe-prescribing-working-group.pdf
22. Oshikoya KA, et al. Ability of medical students to calculate drug doses in children after their paediatric attachment. Pharm Pract (Granada) 2008;6(4):191–6.
23. Heaton A, et al. Undergraduate preparation for prescribing: the views of 2413 UK medical students and recent graduates. Br J Clin Pharmacol 2008;66(1):128–34.
24. Reid F, et al. Piloting the United Kingdom ‘Prescribing Safety Assessment’ with pharmacist prescribers in Scotland. Res Soc Adm Pharm 2018;14(1):62–8.
25. National Institute for Health and Care Excellence. Shared decision making. NG197. June 2021. Available from: https://www.nice.org.uk/guidance/ng197
26. Bauchner H. Shared decision making in pediatrics. Arch Dis Childhood 2001;84:246.
27. Fiks AG, Jimenez ME. The promise of shared decision-making in pediatrics. Acta Paediatrica 2010;99:1464–6.
28. Griffith R. What is Gillick competence? Hum Vaccin Immunother 2016;12:244–7.

Declaration of interests
None to declare.

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