Review Article

In Search of Comparative Suitability Among Biopharmaceutical Classification System (BCS) and Biopharmaceutical Drug Disposition Classification System (BDDCS)

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ABSTRACT

The determination of properties of drugs like solubility, permeability, and metabolism is a fundamental component of rational drug design and also regulatory decision making. Various methods are developed to simplify and guide this process, the Biopharmaceutical Classification System (BCS) and the Biopharmaceutical Drug Disposition Classification System (BDDCS) stand out as widely adopted framework. Although both systems rely on aqueous solubility as their primary input, they differ in their secondary classification criteria-BCS utilizes intestinal permeability, while BDDCS uses the extent of metabolism. This review provides a comparative analysis of the theoretical foundations, how drugs are classified, and real-world application of BCS and BDDCS. In addition to outlining the structure and uses of both system, this review presents case studies of drug classified differently as per BCS and BDDCS framework, explores their individual and joint potential in formulation development, and examines their compatibility with advance tools present in the field such as Physiologically Based Pharmacokinetic (PBPK) modeling, machine learning, and personalized medicine. In the coming future the merging of these two systems into a combined, AI integrated classification model that could dramatically improve the predictive accuracy and efficiency in drug development.

Keywords: Biowaiver, Metabolism, Permeability, Solubility, Transporter.

INTRODUCTION

The goal of successful drug development relies on understanding and predicting how a drug molecule behaves once it is administered, especially in the case of orally administered medications. Drug absorption of orally administered drugs is governed by a complex interplay of physicochemical properties of the drug molecule, biological barriers, and physiological variables. Among all determinants, the most critical determinants are aqueous solubility, intestinal permeability, and first-pass metabolism. The science of biopharmaceutics integrates these concepts to interlink formulation science and pharmacokinetics, to guide formulation strategies and risk assessment in early and late-stage development.[1] To rationalize and standardize the classification of drug molecules based on their biopharmaceutical characteristics, two major classification system have emerged; the Biopharmaceutical Classification System (BCS) and the Biopharmaceutical Drug Disposition Classification System (BDDCS). Biopharmaceutical Classification System (BCS), originally introduced to correlate in vitro dissolution and in vivo bioavailability, which focuses on solubility and intestinal permeability. Its primary use lies in identifying drug candidates suitable for biowaivers—regulatory provisions that allow approval based on in vitro data alone.[1]

Biopharmaceutical Classification System (BCS) supports regulatory decisions by classifying drugs into four categories, based on two criteria's solubility and permeability thresholds. Drugs that fall into BCS Class I (high solubility, high permeability) are ideal candidates for waivers of in vivo bioequivalence studies. These regulatory efficiencies are very critical, as it speed up the availability of affordable generic medicines. The classification is based on well-established criteria, such as solubility across pH 1–7.5 and 85% absorption in humans.[2] On the other hand BDDCS replaces permeability with extent of metabolism, it is based on the observation that drugs which are having high passive permeability are usually extensively metabolised, while the poorly permeable drugs tends to be excreted unchanged. This change in logic of classification allows BDDCS to focus on drug disposition rather than absorption, that results in better predictive value for hepatic metabolism and transporter interactions.[3] As mentioned in different pharmacokinetic studies, BDDCS provides an improved framework for anticipating drug-drug interactions and predicting clearance mechanism, especially for those drugs that are affected by cytochrome P450 enzymes and efflux transporters such as Pgp and Breast Cancer Resistance Protein (BCRP).[4] These transporters enzymes interplay predictions are increasingly vital in drug safety assessments.[5,6] Moreover, differences in drug absorption and metabolism across population due to genetic polymorphism, age related physiological changes, or coexisting conditions can profoundly impact pharmacokinetics.[7] Biopharmaceutical Drug Disposition Classification System (BDDCS) is better positioned than BCS to anticipate such variability, enabling more individualized approaches in clinical pharmacology.[8]

The increase in the Model-informed drug development (MIDD) and physiologically based pharmacokinetic (PBPK) modelling further refine the usefulness of both systems.[9] Biopharmaceutical Classification System (BCS) parameters are used to inform absorption models, while BDDCS

contributes to distribution, metabolic, and clearance predictions- together supporting safer and more cost-effective trail designs.[10,11] This review explores the theoretical foundations, practical applications, drawbacks and future potential of BCS and BDDCS. This study emphasizes how these systems can be used together to increase efficient drug design, potential risk assessment, and regulatory compliance throughout the drug development chain.[12]

BIOPHARMACEUTICAL CLASSIFICATION SYSTEM (BCS) AND BIOPHARMACEUTICAL DRUG DISPOSITION CLASSIFICATION SYSTEM (BDDCS): OVERVIEW

The Biopharmaceutical Classification System (BCS) was developed to classify orally administered drugs based on their aqueous solubility and intestinal permeability. These two parameters were found to be important for predicting that rate and extent of oral absorption, which is a key factor of bioavailability. Biopharmaceutical Classification System (BCS) classifies drugs into four classes:[12]

Class I: High solubility, high permeability

Class II: Low solubility, high permeability

Class III: High solubility, low permeability

Class IV: Low solubility, low permeability

Solubility is considered as high when the highest dose strength is soluble in 250mL or less of aqueous media across a pH range 1 to 7.5. Permeability is generally determined using in vivo absorption data or in vitro models like Caco-2 cells. Drugs that belong to Class I are considered optimal for oral delivery, as they are both readily soluble and permeable, resulting in their efficient absorption without the need for complex formulation.[9] Biopharmaceutical Classification System (BCS) is particularly important with respect to biowaivers- regulatory allowances that waive the requirement for in vivo bioequivalence studies based on in vitro data. Drugs that belong to Class I or sometimes Class III (with conditions) are eligible, remarkably speeding up generic drug approvals and reducing costs.[9]

Whereas on the other hand, the Biopharmaceutical Drug Disposition Classification System (BDDCS), proposed by Benet *et al.*, deviates the focus from permeability to extent of metabolisms. This change was based on the observation that highly permeable drugs tend to be extensively metabolised and vice versa. Biopharmaceutical Drug Disposition Classification System (BDDCS) also drugs into four categories, using the same solubility criteria but replacing permanently with metabolic behaviour:[13]

Class I: High solubility, extensively metabolised

Class II: Low solubility, extensively metabolised

Class III: High solubility, poorly metabolised

Class IV: Low solubility, poorly metabolised

Unlike BCS, BDDCS provides information about hepatic metabolism, transporters, pharmacokinetic modelling, and safety evaluation. It can predict the role of enzymes {e.g. cytochrome P450 (CYP450 family)}and efflux/influx transporters {e.g. P-glycoprotein 1 (Pgp), Organic anion-transporting polypeptides (OATP)} in deciding a drug's disposition.[5] Biopharmaceutical Classification System (BCS) and Biopharmaceutical Drug Disposition Classification System (BDDCS), both together offer supporting insights: BCS simplifies regulatory decision making, while BDDCS increases mechanistic understanding of drug behaviour, they represent different entry points in the drug development process- BCS in formulation and regulatory phases, and BDDCS in discovery and early pharmacokinetic profiling.[14] Additionally, BDDCS is also helpful in identifying the variability in drug response, especially in patients with genetic polymorphism in enzymes or transporters. This predictive utility is an excellent foundation for personalized medicine strategies.[15]

COMPARISON OF BCS VS BDDCS:

Biopharmaceutical Classification System (BCS) and Biopharmaceutical Drug Disposition Classification System (BDDCS) both the classification systems use solubility as a common parameter, their distinct secondary criteria result in altered forecasts and applications. Biopharmaceutical Classification System (BCS) is built around the criterion permeability of the drug, which emphases on drug entry into the systemic circulation. On the other hand, BDDCS's use the extent of metabolism which focuses on drug removal and transformation, offering a better picture of systemic clearance of the human body.[13] Biopharmaceutical Classification System (BCS) is often used in regulatory submissions to rationalize the waiving of in vivo bioequivalence trials. Its strength is its smoothness in using quantifiable in vitro data to support drug approval processes. But it provides limited information about what happens to the drug after it is absorbed in the body- such as in what way it is metabolised in the body, whether it's a substrate for transporters, or it interacts with other drugs.[5]

Biopharmaceutical Drug Disposition Classification System (BDDCS) radiates in this post- absorption part. It predicts enzyme- transporter interplay, hepatic removal, organ targeting and important factors in drug -drug interactions studies, toxicity evaluation, and CNS penetration modelling. For example, a BCS class I drug might be well absorbed, but it may fail to reach the brain due to P-glycoprotein 1 (Pgp) efflux. Biopharmaceutical Drug Disposition Classification System (BDDCS) helps to identify such risks in early phases.[6] Considering atenolol, which is classified as BCS Class I due to its solubility and permeability. However, it is minimally metabolised in the body and excreted unchanged in urine, BDDCS classifies the same atenolol as Class III. This shows a risk of renal clearance differences that BCS alone would not detect.[16] Comparing this with metoprolol, which is BCS and BDDCS Class I. It is well absorbed and extensively metabolised, making it more predictable in terms of bioavailability and therapeutic consistency. Another example is propranolol, though it also belongs to Class I in BCS, it undergoes extensive first pass metabolism, which

means that its oral bioavailability can decrease significantly, especially in the case of liver-paired patients.[17]

These differences are important in physiologically based pharmacokinetic (PBPK) modelling, where BCS data informs absorption models, and BDDCS nurtures into clearance and distribution parameters. PBPK simulations for special population (e.g., paediatrics, geriatrics, hepatic/renal impairment patients) often depend heavily on BDDCS insights.[18] In formulation science, BCS shows focus toward increasing the solubility and dissolution, while in case of BDDCS it influences metabolic stability, transporters inhibition, and prodrug design. Mutual use of BCS and BDDCS enables more robust, fruitful, and more predictive product development plans.[19] Finally, the combined application of BCS and BDDCS is gaining grip in Model-Informed Drug Development (MIDD), where developers rely on mechanistic models rather than actual guesswork. Together they help in reducing failure rates in late stage trails and improve overall drug safety profile.[20]

BENEFITS AND DRAWBACKS OF BCS:

Benefits of BCS may be coined and presented as below-

Widespread Regulatory Acceptance

The Biopharmaceutical Classification System (BCS) has been officially recognized by regulatory agencies such as the US FDA, EMA, and WHO. Its addition in various regulatory guidelines helps in drug developers to utilize in vitro dissolution and permeability data instead of organising high cost and time-consuming in vivo bioequivalence (BE) studies**,** particularly for the drugs that belongs to BCS Class I and certain drugs of Class III**.**[9]

Facilitates Biowaivers

One of the greatest impactful application of BCS is its capability to grant biowaivers, making the approval of generic formulations easy. This is particularly valuable for companies that are operating under tight budget as it decreases the use of human pharmacokinetic trails.[12]

Simplified Drug Development Pathways

Biopharmaceutical Classification System (BCS) provides early-stage prediction of absorption behaviour, resulting in formulators to design dosage forms on the basis of solubility and permeability profiles. For example**,** Class II drugs**,** which are poorly soluble but highly permeable, may benefit from solubility enhancement strategies like amorphous solid dispersions or nanoparticulate formulations.[14]

Efficient Screening Tool

Since BCS relies on easy measurable properties that is solubility and permeability it serves as an efficient screening tool during the phase of drug discovery. Formulators can quickly eliminate those drugs which are poorly soluble and poorly permeable compounds (Class IV) from further development or apply risk-mitigation strategies.[21]

Supports Quality by Design (QbD)
In the current scenario of modern QbD framework, BCS data helps in the identification of critical quality attributes (CQAs) for dissolution, permeability, and formulation robustness—supporting regulatory filings with more scientific justification.[2]

Drawbacks of BCS may be noted and presented as below-

Limited Scope Beyond Absorption

Biopharmaceutical Classification System (BCS) is no doubt an excellent tool for predicting oral absorption, but it offers no information about hepatic metabolism**,** enzyme-substrate interactions, or systemic clearance mechanisms. Thus, those drugs which are well absorbed but quickly metabolized may be miscalculated in terms of efficacy.[5]

Unclear Permeability Cut-offs

Classification of permeability often relies on comparison of a test drug to reference drugs or cell-line models (e.g., Caco-2), which may not always reflect the actual in vivo behaviour of the human body. This can lead to borderline misclassification, especially for those compounds which are near the solubility or permeability thresholds.[22]

Neglects Transporter Impact

Biopharmaceutical Classification System (BCS) does not account for the influence of efflux (e.g., Pgp) or uptake transporters**,** which can drastically alter the bioavailability of the drug, particularly in case of CNS drugs or drugs with restricted hepatic access.[23]

BENEFITS AND DRAWBACKS OF BDDCS:

Benefits of BDDCS may be coined and presented as below-

Focus on Systemic Drug Disposition

Biopharmaceutical Drug Disposition Classification System (BDDCS) comprises hepatic metabolism as a subordinate criterion, that results into a more furnished understanding of drug elimination process, half-life, and organ distribution. This is very important for guessing the systemic exposure, especially in drugs undergoing extensive first-pass metabolism.[13]

Predictive of Transporter and Enzyme Interplay

Biopharmaceutical Drug Disposition Classification System (BDDCS) can accurately look for transporter-enzyme interactions, which are important in predicting drug–drug interactions, especially for those kinds of drugs that are substrates or inhibitors of CYP enzymes or Pgp **/** Organic anion-transporting polypeptides **(**OATP) transporters.[6]

Supports PBPK and MIDD Approaches

Biopharmaceutical Drug Disposition Classification System (BDDCS) provides very critical information for physiologically based pharmacokinetic models (PBPK) and supports model-informed drug development (MIDD)**.** Biopharmaceutical Drug Disposition Classification System (BDDCS) metabolism-based classification helps in polishing

predictions for both special populations (e.g., children, elderly) and disease-specific pharmacokinetics.[10]

Application in CNS and Targeted Therapy

Drugs that are being targeted to the brain or liver require models that account for efflux barriers and organ-specific enzymes**.** Biopharmaceutical Drug Disposition Classification System **(**BDDCS) provides this upper hand by evaluating not just permeability criteria, but also how metabolism affects drug access and retention at target sites.[18]

Drawbacks of BDDCS may be noted and presented as below-

Requires Metabolism Data

One of the key drawbacks of BDDCS is that it depends on in vivo or in vitro metabolism data**,** which are most often not available during the early drug discovery. This may decrease its use as a front-line screening tool or surrogate models.[5]

Lacks Regulatory Biowaiver Support

Biopharmaceutical Classification System (BCS) is recognised in regulatory guidelines, but BDDCS is not yet recognized in regulatory guidelines as a basis for biowaivers. In spite of its robust scientific grounding, its lack of formal acceptance limits its use in filings or approvals.[22]

Less Familiar Among Formulators

Biopharmaceutical Drug Disposition Classification System (BDDCS) is less extensively taught or accepted outside theoretical and demonstrating communities. As a result, many formulation scientists are not known with its application or hesitant to use it into routine development workflows.[24]

FUTURE OUTLOOK

As pharmaceutical sciences are moving towards greater integration of computational modelling, artificial intelligence (AI), and real-time data analytics both the classification systems BCS and BDDCS are expected to evolve and become increasingly involved in predictive development workflows. The shift from empirical formulation to model-informed drug development (MIDD) is reorganizing how these classification systems are used- not only to describe existing properties but to predict future outcomes.[10] One of the most promising development to look forward is the application of machine learning (ML) algorithms to predict BCS and BDDCS classifications directly from chemical structure**.** Recent advancements have enabled the use of AI tools to forecast the solubility and permeability data of a particular compound, and even extent of metabolism without wet-lab experiments. These predictions can then be used to sort compounds, identify formulation risks, and even simulate clinical pharmacokinetics in silico.[18] The coming of personalized medicine also calls for a rethinking of static classification systems. However, variability in genetics (e.g., CYP450 polymorphisms), associated conditions (e.g., liver or kidney disease), and population factors (e.g., age, sex, ethnicity) can significantly alter a drug's absorption and metabolism. In the coming generation of classification there may be models that involve adaptive criteria that will consider patient specific profiles that will bring BCS and BDDCS into the realm of precision pharmacotherapy.[8] In addition, the availability of high-throughput screening tools for transporter activity and metabolic stability both is expected to increase the accuracy and scope of BDDCS. As in the coming future the dataset will grow, machine learning models will be more trained on these and the results will become more reliable, thus ensuring earlier and more confident classification of new chemical entities.[25]

In future, we are likely to see the development of hybrid classification systems that will combine the strengths of BCS (focus on solubility and permeability) with those of BDDCS (focus on metabolism and transporter interactions).[24] Industry leaders are already developing software that automatically suggests different formulation strategies, assumes clinical performance, and detects potential risks on the basis of integrated classification input. This will make faster, more intelligent decision-making and will significantly reduce development failures caused by poor absorption, unpredictable metabolism, or unknown interactions.[19] Regulatory agencies are also beginning to explore and utilise how MIDD, PBPK, and BDDCS data can be merged into adaptive licensing models offering provisional approvals based on modelled performance in early-phase human trials. This represents a significant shift in how drug development is governed and monitored.[20]

CONCLUSION

The Biopharmaceutical Classification System (BCS) and the Biopharmaceutical Drug Disposition Classification System (BDDCS) both of them have recognized to be powerful and genuine tools in current pharmaceutical development. While both of them rely on aqueous solubility as a common criterion, their distinct secondary parameters are permeability for BCS and metabolism for BDDCS that allows them to serve different but highly complementary roles across the drug development channel.[26] Biopharmaceutical Classification System (BCS) has transformed regulatory science by providing a technically systematic basis for biowaivers, thereby dropping time and cost in the development of generic drugs. Its upfront methodology helps the formulation teams and regulatory reviewers to assess the oral absorption potential of drug compounds using in vitro models.[14] While on the other hand, BDDCS offers greater predictive skill when it comes to disposition of drug inside human body, mainly regarding hepatic metabolism**,** enzyme-transporter interplay**,** and clearance pathways. Its strong point lies in the early-phase drug discovery processes**,** where understanding a compound's metabolic outcome is serious for anticipating drug-drug interactions, optimizing tissue targeting (especially CNS drugs), and designing rational formulations for systemic delivery.[13]

Biopharmaceutical Classification System (BCS) surpasses in evaluating oral bioavailability and design needs, while

BDDCS predicts downstream effects such as metabolism-driven inconsistency, potential efflux risks, and clearance routes. Together, they support more informed decisions across preclinical, clinical, and regulatory domains.[20] As drug development continues to progress and which is going to be driven by AI, PBPK modelling, and personalized medicine the incorporation of BCS and BDDCS is no longer just useful, but essential. Future innovations will likely build on these types of models, including real-time data, adaptive classification algorithms, and patient-specific restrictions to deliver safer, more effective therapies with extraordinary efficiency.[24]

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REFERENCES

1. Lo R. Modern bioavailability, bioequivalence and biopharmaceutics classiÆcation system. New scientific approaches to international regulatory standards. 2000;50:3–12.

2. Dahan A, Miller JM & Amidon GL. Prediction of Solubility and Permeability Class Membership: Provisional BCS Classification of the World's Top Oral Drugs. *AAPS J.* 2009 Dec;11(4):740–746.

3. Heimbach T, Xia B, Lin T han & He H. Case Studies for Practical Food Effect Assessments across BCS/BDDCS Class Compounds using In Silico, In Vitro, and Preclinical In Vivo Data. *AAPS J.* 2013 Jan;15(1) (2013):143–158.

4. AL-Kamarany MA, Karbane ME, Alanazi F, Cherrah Y & Bouklouze A. Effect of Biopharmaceutical Classification System on Pharmacokinetic and Mechanism of Drug Release In vitro. *Abhath J Basic Appl Sci*; 2022;2(2):49–53.

5. Broccatelli F, Cruciani G, Benet LZ & Oprea TI. BDDCS Class Prediction for New Molecular Entities. *Mol Pharm*. 2012 Mar 5;9(3):570–80.

6. Broccatelli F, Larregieu CA, Cruciani G, Oprea TI & Benet LZ. Improving the prediction of the brain disposition for orally administered drugs using BDDCS. *Adv Drug Deliv Rev,* 2012 Jan;64(1):95–109.

7. Motwani A P H, Advances in solubility enhancement of poorly soluble drugs in pharmaceutical development: A review of current techniques and strategies, *Int J Pharm Sci*, 2024;2(11):138–148.

8. Samineni R, Chimakurthy J & Konidala S. Emerging Role of Biopharmaceutical Classification and Biopharmaceutical Drug Disposition System in Dosage form Development: A Systematic Review. *TJPS,* 2022 Dec 21;19(6):706–713.

9. Karalis V, Magklara E, Shah VP & Macheras P. From Drug Delivery Systems to Drug Release, Dissolution, IVIVC, BCS, BDDCS, Bioequivalence and Biowaivers. *Pharm Res.* 2010 Sep;27(9):2018–2029.

10. Bocci G, Benet LZ & Oprea TI. Can BDDCS illuminate targets in drug design? *Drug Discov Today*, 2019 Dec;24(12):2299–2306.

11. Varma MV, Gardner I, Steyn SJ, Nkansah P, Rotter CJ & Whitney-Pickett C, et al. pH-Dependent Solubility and Permeability Criteria for Provisional Biopharmaceutics Classification (BCS and BDDCS) in Early Drug Discovery. *Mol Pharm*. 2012 May 7;9(5):1199–1212.

12. Lennernäs H, Abrahamsson B. The use of biopharmaceutic classification of drugs in drug discovery and development: current status and future extension. *J Pharm Pharmacol*. 2005 Mar 1;57(3):273–285.

13. Larregieu CA, Benet LZ. Distinguishing between the Permeability Relationships with Absorption and Metabolism To Improve BCS and BDDCS Predictions in Early Drug Discovery. *Mol Pharm*. 2014 Apr 7;11(4):1335–1344.

14. Benet LZ, Hosey CM, Ursu O & Oprea TI. BDDCS, the Rule of 5 and drugability. *Adv Drug Deliv Rev.* 2016 Jun;101:89–98.

15. Corrigan I & Owen I, The biopharmaceutic drug classification and drugs administered in extended release (ER) formulations, in *Adv Exp Med Biol*, edited by Gyorgy P & Pearson W N N (Springer US, Boston, MA) 1997, 111–128.

16. Benet LZ. The Role of BCS (Biopharmaceutics Classification System) and BDDCS (Biopharmaceutics Drug Disposition Classification System) in Drug Development. *J Pharm Sci*. 2013 Jan;102(1):34–42.

17. Benet LZ, Cummins CL & Wu CY. Unmasking the dynamic interplay between efflux transporters and metabolic enzymes. , *Int J Pharm.* 2004 Jun;277(1–2):3–9.

18. Khandelwal A, Bahadduri PM, Chang C, Polli JE, Swaan PW & Ekins S. Computational Models to Assign Biopharmaceutics Drug Disposition Classification from Molecular Structure. *Pharm Res.* 2007 Nov 5;24(12):2249–62.

19. Lipinski CA. Lead- and drug-like compounds: the rule-of-five revolution. *Drug Discov Today Technol:* Technologies. 2004 Dec;1(4):337–41.

20. Shugarts S, Benet LZ. The Role of Transporters in the Pharmacokinetics of Orally Administered Drugs. *Pharm Res*. 2009 Sep;26(9):2039–2054.

21. Chen ML, Amidon GL, Benet LZ, Lennernas H & Yu LX. The BCS, BDDCS, and Regulatory Guidances. *Pharm Res.* 2011 Jul;28(7):1774–1778.

22. Custodio JM, Wu CY & Benet LZ. Predicting drug disposition, absorption/elimination/transporter interplay and the role of food on drug absorption. *Adv Drug Deliv Rev*. 2008 Mar;60(6):717–733.

23. Cristofoletti R, Chiann C, Dressman JB & Storpirtis S. A comparative analysis of biopharmaceutics classification system and biopharmaceutics drug disposition classification system: A cross-sectional survey with 500 bioequivalence studies. *J Pharm Sci*. 2013 Sep;102(9):3136–3144.

24. Zhang Y, Benet LZ. The Gut as a Barrier to Drug Absorption: Combined Role of Cytochrome P450 3A and P-Glycoprotein. *Clin Pharmacokinet*. 2001;40(3):159–68.

25. Chan R, Benet LZ. Evaluation of the relevance of DILI predictive hypotheses in early drug development: review of in vitro methodologies *vs.* BDDCS classification. *Toxicol Res.* 2018 May 8;7(3):358–70.

26. Wu CY, Benet LZ. Predicting Drug Disposition via Application of BCS: Transport/Absorption/ Elimination Interplay and Development of a Biopharmaceutics Drug Disposition Classification System. *Pharm Res.* 2005 Jan;22(1):11–23.