Revenue Potential for Inpatient IR Consultation Services: A Financial Model

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ABSTRACT

Purpose: Interventional radiology (IR) has historically failed to fully capture the value of evaluation and management services in the inpatient setting. Understanding financial benefits of a formally incorporated billing discipline may yield meaningful insights for interventional practices.

Materials and Methods: A revenue modeling tool was created deploying standard financial modeling techniques, including sensitivity and scenario analyses. Sensitivity analysis calculates revenue fluctuation related to dynamic adjustment of discrete variables. In scenario analysis, possible future scenarios as well as revenue potential of different-size clinical practices are modeled.

Results: Assuming a hypothetical inpatient IR consultation service with a daily patient census of 35 patients and two new consults per day, the model estimates annual charges of $2.3 million and collected revenue of $390,000. Revenues are most sensitive to provider billing documentation rates and patient volume. A range of realistic scenarios—from cautious to optimistic—results in a range of annual charges of $1.8 million to $2.7 million and a collected revenue range of $241,000 to $601,000. Even a small practice with a daily patient census of 5 and 0.20 new consults per day may expect annual charges of $320,000 and collected revenue of $55,000.

Conclusions: A financial revenue modeling tool is a powerful adjunct in understanding economics of an inpatient IR consultation service. Sensitivity and scenario analyses demonstrate a wide range of revenue potential and uncover levers for financial optimization.

ABBREVIATIONS

APC = advanced practice clinician, E&M = evaluation and management, FTE = full-time equivalent

Interventional radiology (IR) brings added value to radiology practices. Traditionally, it has done so by demonstrating improved procedural morbidity and mortality compared with surgery, often in conjunction with decreased costs and enhanced patient outcomes (1–4).

More recently, the IR community has stressed the value of becoming more “clinical” by seeing patients with a primary physician in inpatient and outpatient settings (5–10).

Inpatient IR consultation services represent one such effort, undoubtedly providing clinical benefits and signaling the transition of IR to a more traditional clinical care delivery model. An inpatient IR consultation service may provide full consultations for patients in whom an IR intervention may be warranted, as well as follow patients longitudinally during the course of their hospital stay following IR procedures. Although IR physicians increasingly recognize the clinical importance of nonprocedural services, there is a paucity of literature regarding the financial impact of these activities. From a practice perspective, inpatient IR practices are potential sources of revenue diversification when faced with declining reimbursements for procedural services (11). Additionally, with many interventional radiologists already providing...
clinical services without explicitly billing for all of them, an understanding of the financial implications may be important such that fair reimbursement can be obtained.

Existing literature is limited. Duszak and Borst (12) showed that Medicare IR claims for nonprocedural clinical encounters increased by 1,200% from 1993 to 2008, with 1,112% growth attributed to the inpatient setting. Recently, White et al (13) demonstrated that a structured approach to increasing relative value unit capture in the inpatient setting resulted in significant gains for their practice. In their analysis, a team approach was implemented to improve revenue capture over a 3-year period, resulting in 722% growth in evaluation and management (E&M) billing charges and 831% growth in collected revenues. These studies—while encouraging for those interested in growing such service lines—are limited because they describe single-institutional experiences in a retrospective manner. We are aware of no published literature describing dynamic analyses capable of predicting future financial potential in a plethora of settings.

The present study describes a financial model capable of predicting revenues of an inpatient IR consultation service. The financial model not only projects future revenues of a service but also conducts sensitivity and scenario analyses to understand revenue potential under varying circumstances. Radiology practices may use this model to justify and even design a new inpatient IR consultation service with maximum clinical and economic rewards.

MATERIALS AND METHODS

Model Mechanics

Financial modeling is the process by which one can construct a financial representation of everything ranging from an individual product to an entire organization (14,15). Models are built on a series of simple calculations and are used widely in financial services firms on Wall Street (eg investment banks, investment management, or venture capital/private equity), management consulting firms, and finance operations within companies. Models mimic financial statements but earn their name as “models” because of their dynamic quality. Similar techniques have been rarely deployed in the medical literature, although financial modeling has previously been used to estimate cost savings of rehabilitation programs in the intensive care unit and viability of a specialty orthopedics hospital (16,17).

The financial model described here was developed in Excel (Microsoft, Redmond, Washington) with the use of standard modeling techniques, building on the basic concept of revenue reflecting the product of quantity and price. Health Insurance Portability and Accountability Act compliance and institutional review board approval were not applicable because no patient data were reviewed in the development of this theoretical predictive model. The model reflects a full-fledged inpatient IR consultation service. Clinicians staffing the service are assumed to see patients for whom new consultations are requested by primary teams (eg, evaluation for intra-abdominal abscess drainage catheter placement or arterial angiography and embolization for gastrointestinal bleeding). Clinicians are also assumed to longitudinally follow existing patients known to the service on a daily basis until IR input is no longer required. In this model, revenue is calculated as a product of the following: average patient volume × E&M case mix × staffing mix × documentation compliance × charges × collection rate. All inputs to the model are purposefully made to be flexible, such that any set of assumptions can be entered and altered with ease. The Appendix and Table E1 (available online at www.jvir.org) include further details on model mechanics, including a step-by-step illustration of model calculations and results.

Model Assumptions

Average patient volume reflects the hypothetical number of patients on the census, which is derived from the dual sources of recent procedures as well as ongoing new inpatient IR consultation. E&M case mix estimates the breakdown of cases from levels 1 through 5 (new consults) or levels 1 through 3 (existing consults) based on complexity of care delivered. Staffing mix includes the percentage of patients seen by attending physicians versus advanced practice clinicians (APCs) alone. Staffing mix also reflects variance in billing revenue, as independent APCs have the ability to bill at 85% of the rate of attending physicians. Documentation compliance indicates the rate at which providers complete required paperwork for billing (eg complete notes and filling out computerized billing paperwork to actually charge for the visit). Although global period reduction was initially hypothesized to be a significant driver, analysis of case mix at the authors’ institution demonstrated this to be a negligible factor; hence, although this functionality was built into the model for purposes of future exercises, no specific assumptions were developed for the present manuscript. Charges reflect the amount that practitioners charge for patient visits and vary depending on visit type. Finally, collection rate includes an estimated gross collection rate on those same charges.

Baseline assumptions were built from experiences at the authors’ institution, with ranges assigned for purposes of simplicity as well as confidentiality. Review of the literature reveals no comparable studies in developing assumptions necessary for this model, likely because of the inherently proprietary nature of many of these assumptions. Additionally, final assumptions were pressure-tested with clinical and financial staff, including the director of finance, two financial analysts, and three IR physicians, to ensure they reflect realistic, albeit
hypothesized, situations (Table 1). This technique for developing assumptions is commonplace in financial services and consulting firms.

A baseline revenue estimate is built based on a patient volume of an existing consult patient census of 35 with two new consultations per day. Attending physicians are modeled as leading the service and staffing (ie, conducting a full patient visit and writing a clinical note) approximately 50% of higher-level care (E&M levels 2 and 3) and 15% of lower-level care (E&M level 1) visits with patients known to the service. Attending physicians are also assumed to staff all new consultations, or patients new to the service. All remaining patients—almost exclusively cases of lower acuity—are modeled to be seen independently by one of two APCs on service without full attending physician staffing. Documentation compliance for reimbursement is also estimated, with the assumption that APCs and attending physicians fully document for reimbursement 80% and 40% of the time, respectively. Hypothetical charges ($150–$750 per visit) are applied for the purposes of modeling. The range for charges was derived from estimates from internal values at the authors’ institution; as these values are confidential, general ranges are used and further granularity is not publishable. Collection rate is estimated to range between 15% and 25% of total charges and is similarly based on internal experience.

### Sensitivity and Scenario Analysis

The next step in the analysis was to perform sensitivity and scenario analyses to assess the range of potential revenues that can be expected in the future. In sensitivity analysis, individual inputs into the model are flexed to assess their individual impact on revenues. For example, the percentage of patients seen by an attending physician versus an APC alone may be adjusted upward or downward to assess the revenue impact of attending staffing. The model is designed to assess the spread of outcomes (eg minimum, baseline, maximum) within a reasonable range of assumptions.

Scenario analysis allows the user to “paint a picture” of what the world looks like when multiple levers are tweaked simultaneously in contrast with the base case scenario. Such analyses simulate the real world, in which multiple circumstances will inevitably change at once. For instance, in an optimistic scenario, the model assumes that certain variables that can be reasonably controlled (ie, provider mix, documentation compliance) will be optimized. In contrast, in the cautious scenario, assumptions are made to project loss of patient volume, evolution of an unfavorable patient mix, and decreased attending physician time with patients (Fig 1).

Separately, scenario analysis also models the range of revenues expected from different-size interventional practices. For example, small, moderate, large, and “mega” clinical practices can be estimated based on the number of patients and consultations balanced against personnel required to staff practices. Workload as well as estimated revenues per APC or attending physician can also be calculated to understand viability of formal inpatient IR consultation services under different practice models.

### RESULTS

#### Baseline Revenue Potential

Assuming a hypothetical inpatient IR consultation service with an average daily patient census of 35 patients and approximately two new consults per day and additional assumptions as detailed earlier, the model estimates potential total annual charges of $2,264,672 and collected annual revenue of $389,612. The majority of patient encounters as well as collected revenue (95%) are attributed to caring for existing patients as opposed to new consultations. APCs shoulder a large amount of the clinical responsibilities, with a total of 4,400 annual inpatient clinical encounters per APC, or 18 visits per day. In this base case, estimated collected revenue per APC is approximately $194,806.

### Sensitivity and Scenario Analysis for Baseline Revenues

Sensitivity analysis demonstrates that significant gains in hypothetical revenue can be obtained by modulating specific factors; Figure 2 provides graphical representation of the relative magnitude of the impact of such modulations. For example, sensitivity analysis of provider documentation for existing patients demonstrates that collected revenue would decrease by $138,295 or 35% if documentation rate decreases to 50% from its
current estimate of 80%. In contrast, hypothetically improving documentation rate to 100% would increase revenue by $92,197, or 24%. Additional factors with meaningful impact on collected revenue include patient volume and, to a lesser extent, provider compliance with documentation for new consults. In contrast, the provider mix (ie, whether APCs see patients alone without full attending physician staffing) for even higher levels of care had little ultimate impact on revenues (eg, increasing volume of cases seen by APCs alone by 50% results in small revenue variations of $7,932 [1%] for level 2 care and $5,023 [2%] for level 2 care); this phenomenon is likely secondary to the fact that APCs bill at 85% of the rate of attending physicians.

Figure 1. Chart demonstrating potential future scenarios and projected change in various levers (e.g. provider mix, average census) relative to the base case. (a) In the Optimistic case, there are projected to be favorable circumstances related to provider mix, documentation compliance, and collection rates. (b) The Base case is described in detail in the article. (c) In the Cautious case, there are unfavorable circumstances related to multiple levers including average census, E&M mix, provider mix, and collection rates.

**Assumptions** | **Base** | **Range** | **Revenues**
--- | --- | --- | ---
(a) Provider documentation compliance (Existing consults) | 80% | 50% - 100% | -138,295 | 92,197
(b) Average census (Existing consults) | 35 | 30 - 40 | -52,684 | 52,684
(c) New consults/day | 2 | 0 - 4 | -20,825 | 20,825
(d) Provider documentation compliance (New consults) | 40% | 25% - 75% | -7,809 | 18,222
(e) APC alone patient visit (Level 3) | ~50% | 75% - 25% | -7,932 | 7,932
(f) APC alone patient visit (Level 2) | ~50% | 75% - 25% | -5,023 | 5,023

Figure 2. Sensitivity analysis demonstrates positive and negative fluctuations in collected revenue relative to base case of $389,612 upon changing a single variable. (a) Provider documentation for existing patients dropping to 50% results in a loss of 138,295 in revenues whereas improvement to 100% would increase revenues by 92,197. (b) Average census dropping to 30 results in a loss of 52,684 in revenues whereas improvement to 40 would increase revenues by 52,684. (c) Average new patients dropping to 0 results in a loss of 20,825 in revenues whereas improvement to 4 would increase revenues by 20,825. (d) Provider documentation for new consults dropping to 25% results in a loss of 7,809 in revenues whereas improvement to 75% would increase revenues by 18,222. (e) Rates at which APCs see patients alone for Level 3 visits increasing to 75% results in a loss of 7,932 in revenues whereas improvement to 25% would increase revenues by 7,932. (f) Rates at which APCs see patients alone for Level 2 visits increasing to 75% results in a loss of 5,023 in revenues whereas improvement to 25% would increase revenues by 5,023.
Scenario analysis can be used to project future revenues as compared with a base case. As detailed earlier, the base case scenario projects $2.3 million in charges with $390,000 in hypothetical collected revenues. The optimistic case assumes no change in existing patient census, one additional new consult per day, modest gains in provider mix (30% increase in attending physician staffing for complex cases), increased attending physician compliance with documentation (50% increase), and a 5% gain in collection rate, resulting in $2.7 million in charges (19% greater than baseline) with $601,000 in collected revenues (54% greater than baseline). The cautious case assumes shrinking patient volume (15% decrease in volume), lower acuity of care (25% decrease in high-level visits), relatively unfavorable provider mix (ie, 10% decrease in attending physician staffing), no improvement in documentation, and a 5% reduction in collection rate, resulting in $1.8 million in charges (20% less than baseline) and $241,000 in collected revenues (38% less than baseline). Further analyses were performed to assess important metrics as they relate to cautious, base, and optimistic scenarios (Fig 3). The range of annual collected revenues per APC was $120,000–$300,000 for the various scenarios. In addition, average collected revenue per new consultation ranged between $33 and $79, and average collected revenue per existing patient visit ranged between $31 and $65.

Scenario Analysis for Different Practice Sizes

Scenario analysis can also be used to model revenues under different practice models (Table 2). A small practice with five active consultations per day, 0.20 new consults per day, and 0.5 full-time equivalent (FTE) APCs may expect $320,000 in charges with $55,000 in collected revenues. Revenues per APC are $109,000. A moderate-sized practice with 10 active consultations per day, 0.5 new consults per day, and 1.0 FTE APCs may expect $644,000 in charges with $111,000 in collected revenues. Revenues per APC are $111,000. A large practice was modeled as the base case, described in detail earlier. A mega practice with 50 active consultations per day, four new consults per day, and four FTE APCs may expect $3.2 million in charges with $558,000 in collected revenues. Revenues per APC are $140,000.

![Figure 3](image-url)
### Table 2. Scenario Analysis by Size of Practice

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Small</th>
<th>Moderate</th>
<th>Large</th>
<th>Mega</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of APCs (FTE)</td>
<td>0.5</td>
<td>1.0</td>
<td>2.0</td>
<td>4.0</td>
</tr>
<tr>
<td>New consults per day</td>
<td>0.2</td>
<td>0.5</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Existing consults per day</td>
<td>5</td>
<td>10</td>
<td>35</td>
<td>50</td>
</tr>
<tr>
<td>Estimated annual charges ($)</td>
<td>319,579</td>
<td>643,761</td>
<td>2,264,672</td>
<td>3,241,822</td>
</tr>
<tr>
<td>Estimated annual collected revenues ($)</td>
<td>54,766</td>
<td>110,574</td>
<td>389,612</td>
<td>558,075</td>
</tr>
<tr>
<td>Revenues per APC ($)</td>
<td>109,533</td>
<td>110,574</td>
<td>194,806</td>
<td>139,519</td>
</tr>
<tr>
<td>Daily patient volume per APC</td>
<td>10</td>
<td>10</td>
<td>18</td>
<td>13</td>
</tr>
</tbody>
</table>

APC = advanced practice clinician; FTE = full-time equivalent.

**DISCUSSION**

Interventional radiologists work in a health care environment in which longitudinal patient management is increasingly valued. Referring physicians are no longer satisfied with the role of interventionalists as the technical experts, but instead expect and demand that the interventionalist act as a complete clinical physician. Simultaneously, there is a macrotrend within medicine at large moving from a “volume to value” paradigm for reimbursement (18,19). For IR providers, one key element of future care delivery models is seeing patients longitudinally in inpatient and outpatient settings. The importance of longitudinal clinical care in the inpatient setting has been underreported and likely undervalued.

The present analysis provides a unique perspective on financial viability of inpatient IR consultation services. This analysis is forward- and future-facing, inherently designed as a prospective analysis of future revenues. Previously published manuscripts review retrospective experiences at single institutions or provider groups, serving as a vanguard for change but simultaneously severely limiting generalizability. In contrast, some readers may find relevant comparators to their own practices in the small or moderate practice modeling scenarios, whereas others, perhaps in academic medical centers, will draw parallels from large or mega practice modeling scenarios. Interventional radiologists may find this approach useful in thinking about their broader practices beyond the scope of inpatient IR consultation services. There is a dearth of medical literature, and likely also IR practices, employing financial modeling techniques. As medicine moves toward new payment models, proactively understanding and predicting the financial implications of previously purely clinical decisions will be paramount.

IR practices should invest in inpatient IR consultation services. According to this financial model, whether under optimistic or pessimistic future scenarios, sizeable revenue opportunities may be garnered. In addition, commensurate revenue streams are accessible to a broad spectrum of practice sizes, spanning small to mega practices. For many practices, establishing an inpatient IR consultation service may amount to creating a brand new service line. These demonstrated revenue opportunities will help make the business case for these strategic decisions. Practices may also find it useful to compare actual case mix, charges, or collected revenues to those predicted by the model to identify areas for improvement.

For IR practices already engaging in inpatient IR consultation, full revenue capture may be lacking. Even under aggressively modeled current circumstances, a significant proportion of financial value is lost to factors identified in sensitivity analyses, such as a lack of appropriate documentation, as well as the likely habit of informal or “curbside” consultations, for which billing is impossible. Practices may benefit from correcting or avoiding potential lost financial opportunities by being vigilant about documentation as well as diligently following patients even after initial consultation. In contrast, a key insight derived from this analysis is that provider mix ultimately has little impact on collected revenues. Because APCs bill at a relatively high rate relative to attending physicians, the requirement for attending physician signatures on clinical notes and billing paperwork is less critical for revenue capture. As a result, the challenge of assessing opportunity cost of foregone procedural volume versus consultation is somewhat attenuated.

It is of critical importance to communicate that this financial model is not designed to quantify the “halo effect” of an inpatient IR consultation service. “Halo effect” is a term from marketing business literature that explains positive bias of consumers toward a brand secondary to prior favorable experiences with other products/services from the same brand; effectively, halo effect is nearly a synonym for brand equity. The overall impact of an inpatient IR consultation service likely extends far beyond diversification of a practice’s income statement. Increased visibility of IR in the hospital, enhanced relationships with referring doctors, and strengthened ties with patients all have positive immediate and long-term ramifications. Therefore, even if an inpatient IR consultation service may be viable staffed only with APCs, IR doctors should be mindful that short-term gains—eg, decreased rounding responsibilities for IR doctors or time freed for procedures—may ultimately backfire, possibly even as a negative halo effect.
Although this analysis was not designed to examine profitability, inpatient IR consultation services may already be generating a profit. For example, the range of annual collected revenues per APC in various scenarios range from $120,000 to $300,000. A group practicing above the minimum of this range would potentially be able to demonstrate profitability with this business model, given current APC compensation levels. Under APC stewardship, physician time can be relatively minimized and directed toward other clinical activities such as managing new patient referrals or performing revenue-generating procedures. Future studies may be performed to demonstrate profitability.

The present study has several limitations. First, the study design of this analysis is a hypothetical financial modeling analysis. Although this is a widespread technique in the medical literature. It may be difficult to convince physicians of the utility of this technique. Second, although financial implications are drawn, this model does not estimate the potentially quantifiable added clinical value of a visible consultation service. Cementing the role of IR as an active clinical consultation service may be more valuable than collected revenues; the overall “value” may be estimated in a future study. Third, the types of individual practice models vary widely, ranging from academic centers in large, metropolitan cities to smaller private groups in sparsely populated rural regions. Although academic medical centers may draw direct parallels to the larger practices modeled, independent practices may find that the small or moderate practice model is more appropriate for guidance. Finally, payor mix also varies, spanning public and private insurers, and may differ from that of the authors’ institution. Although reasonable windows are modeled for the purpose of analysis, individual practices may or may not find the published findings directly relevant. Customized financial modeling may be necessary in these circumstances.

The present analysis demonstrates that financial modeling can be used to effectively demonstrate that an inpatient IR consultation service can generate sizeable revenues. As such, interventional radiologists may have the opportunity to improve access to IR care in the inpatient setting while ensuring financial health. Future research may elucidate the profitability as well as the overall “value” of such ventures. Diversification of revenue streams and clinical capabilities will serve the IR field well into the future.

REFERENCES

3. Andrevis RT. The financial “halo effect” of an interventional radiology clinic.Paper presented at: Society of Interventional Radiology 32nd Annual Scientific Meeting; March 1–6, 2007; Seattle WA.
APPENDIX

Model Mechanics: Example Calculations and Results

The financial model is a series of simple calculations, each of which reflects an individual step in the conversion of a clinical encounter into collected revenues. Although each calculation may be a single multiplication or addition equation, the sum of many such equations mimics financial statements of existing enterprises.

Recreating the entirety of a dynamic financial model in print form is not feasible. However, the technical aspects of the model may be described by following a single patient cohort from clinical encounter to collected revenues. The example included in this Appendix demonstrates how the model builds from a specific cohort of new patients who undergo level 3 encounters to annual revenues.

In step 1, the model takes a basic assumption of two new consults per day and converts it into a monthly run rate of 40 patient consultations, as monthly performance is an often desired metric for practices. In step 2, the assumption that 7.5% of all new consults are of E&M level 3 is applied to estimate that there are three new consults per month at this level of care. As all E&M level 3 cases are assumed to be fully staffed by an attending physician, step 3 is quite simple; if some of these patients were assumed to be seen by APCs alone, an entirely separate patient flow would be required. Step 4 calculates the total estimated charges per month by multiplying patient visits by a presumed charge master value of $750. Thereafter, reductions for a 40% attending physician compliance with billing paperwork (step 5) and global period reductions (step 6) are applied. In step 7, the estimated charges is multiplied by the gross collection rate of 20% to calculate monthly revenues the practice may collect. Finally, in step 8, this number is annualized to demonstrate that this single patient cohort brings in $2,160 in annual collected revenues.

In the complete model, additional similar analyses are performed for all other levels of care inclusive of new and existing consults. The sum of all patient cohorts or groups estimates the overall collected revenue for the practice.

### Table E1. Financial Model Flow for New Consults at E&M Level 3

<table>
<thead>
<tr>
<th>Step</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 new consults per day × 20 working days per month = 40 new consults per month</td>
</tr>
<tr>
<td>2</td>
<td>7.5% share of E&amp;M level 3 new consults as a proportion of total new consults = 3 new E&amp;M level 3 new consults per month</td>
</tr>
<tr>
<td>3</td>
<td>100% percentage of E&amp;M level 3 new consults staffed by attending physicians = 3 new E&amp;M level 3 new consults per month staffed by attending physicians</td>
</tr>
<tr>
<td>4</td>
<td>$750 charges per complete visit × 40% compliance rate of attending physician with required billing paperwork = $2,250 total charges generated per month</td>
</tr>
<tr>
<td>5</td>
<td>100% percentage of charges estimated due to global period reduction (0% reduction) × 40% compliance rate of attending physician with required billing paperwork = $900 total eligible charges per month</td>
</tr>
<tr>
<td>6</td>
<td>20% gross collection rate for E&amp;M level 3 new consults × 100% percentage of charges estimated due to global period reduction (0% reduction) = $180 collected revenues per month</td>
</tr>
<tr>
<td>7</td>
<td>12 months in a year × 20% gross collection rate for E&amp;M level 3 new consults = $2,160 collected annual revenues from E&amp;M level 3 new consults</td>
</tr>
</tbody>
</table>

E&M = evaluation and management.